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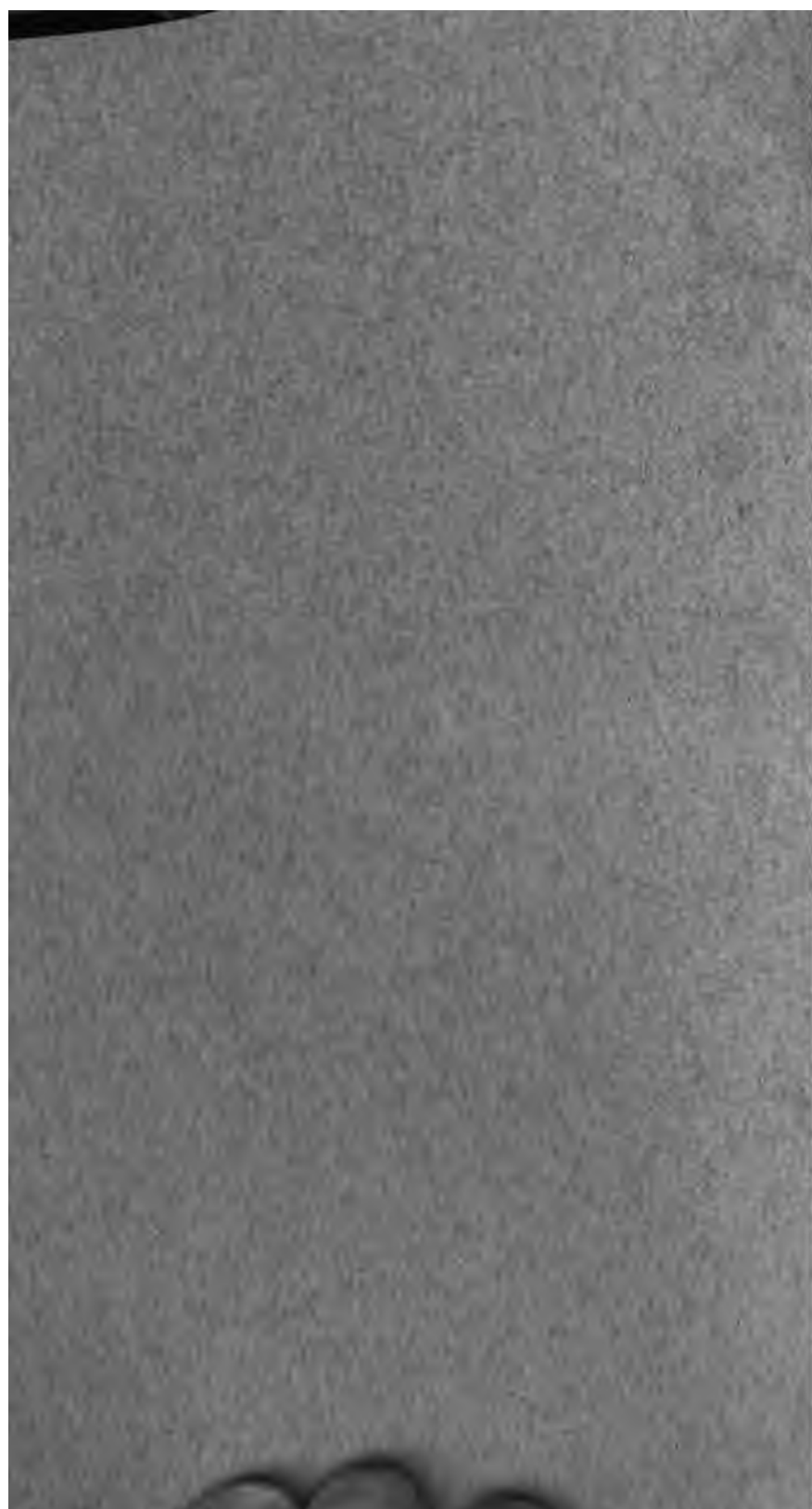
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BULLETIN No. 10.

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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.

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1896-1900
CORNSTALK DISEASE,

AND

RABIES IN CATTLE.

AN INVESTIGATION INTO THE NATURE, CAUSE, AND MEANS OF PREVENTING THE CORNSTALK DISEASE (TOXÆMIA MAIDIS) OF CATTLE.

By VERANUS A. MOORE, B. S., M. D.

A DISEASE IN CATTLE NOT DISTINGUISHABLE FROM RABIES. By VERANUS A. MOORE, B. S., M. D.

CHEMICAL EXAMINATION OF CORNSTALKS PRESUMABLY THE CAUSE OF CORNSTALK DISEASE IN CATTLE. By E. A. DE SCHWEINITZ, M. D., PH. D.

Investigations conducted under the direction of

DR. D. E. SALMON,

Chief of the Bureau of Animal Industry.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., November 22, 1895.

SIR: I have the honor to transmit herewith for publication a report on the cornstalk disease of cattle, and also one covering investigations of a disease which is apparently identical with rabies. The cornstalk disease has brought heavy losses to the cattle feeders of the Western States; its causation has been an unsolved mystery, and much that has been written about it has been incorrect, misleading, and injurious to the interests of the cattle owners and of the country at large.

The investigations of Dr. Moore are given in detail in this report, and have been conducted with great care and with all the facilities that modern science has placed at our disposal. It is shown conclusively that the cornstalk disease is not a disease of the lungs; that it is not a communicable malady; and that it is not even a bacterial disease.

In the past a great deal of discredit has been brought upon American cattle by statements that the cornstalk disease is an infectious disease; that it is caused by pathogenic bacteria, which might be inoculated from animal to animal, and that the disease is identical with the broncho-pneumonia sometimes found in cattle after ocean transit. There have never been made any observations or experiments which gave reasonable justification for such conclusions.

So far as is known the cornstalk disease only affects cattle which have fed upon cornstalks as they stand in the fields. It comes on suddenly, most of the affected animals die within a short time, and post-mortem examination reveals no signs of pneumonia or broncho-pneumonia.

It has never been shown that the American cattle found affected with broncho-pneumonia in Europe had ever eaten cornstalks in the fields, and certainly they could not have fed in that way for three weeks prior to slaughter. Nor is there any evidence that any cattle have ever suffered in this country from cornstalk disease two or three weeks after they ceased eating the standing cornstalks. This hypothesis, therefore, could not possibly be made to conform with the known facts at the time it was promulgated, and the investigations subsequently made have entirely disproved it.

The report under consideration indicates the real nature of this obscure disease and the means by which it may be avoided. The prevention requires some change in the methods of feeding, but these changes are in the direction of better and more economical farming, and they will tend to increase the income of the farm even if the losses from this disease are not considered.

The chemical examinations by Dr. de Schweinitz of cornstalks from fields where the disease occurred are summarized in his report, and appear to confirm the conclusion reached by Dr. Moore.

The discovery of a disease affecting cattle which is very closely related to, if not identical with, rabies, and which is apparently quite common in certain parts of the West, is extremely interesting, and may lead to the suggestion of appropriate preventive measures. It has not yet been determined whether these cattle were bitten by a rabid animal; but as that is the only known cause of rabies it is probable that further inquiry will show that this mysterious disease arises from the bites of dogs or perhaps of some wild animals that are affected with it.

Very respectfully,

D. E. SALMON,

Chief of the Bureau of Animal Industry.

Hon. J. STERLING MORTON,

Secretary of Agriculture.

CORNSTALK DISEASE, AND RABIES IN CATTLE.

AN INVESTIGATION INTO THE NATURE, CAUSE, AND MEANS OF PREVENTING THE CORNSTALK DISEASE (TOXÆMIA MAIDIS) OF CATTLE.

By VERANUS A. MOORE.

(Plates I and II.)

The name "cornstalk disease" has been given to a somewhat mysterious affection from which cattle sometimes suffer while feeding in cornstalk fields late in the fall and early winter. The meaning generally accepted and intended to be conveyed by this term is, that an animal or a number of animals, usually cattle, have died suddenly either while feeding in a cornstalk field or very soon afterwards. From a pathological standpoint, therefore, the term is meaningless, but it has served admirably as a generic term to designate certain fatalities which were not easily explained otherwise. Geographically, this affection is restricted to those sections of the United States where the farmers harvest their corn by picking the ears from the standing stalks, after which cattle are turned into the cornstalk fields. At present, therefore, it is limited in its distribution to the middle and northern portions of the Mississippi Valley.

The disease is very insidious, frequently causing the death of the animals before its presence is suspected. Farmers in the affected region frequently observe that their cattle act perfectly well at night, and on the following morning one or more of them are dead. Local veterinarians and butchers, in making autopsies on the dead animals, report the failure to find lesions sufficient to cause death. Usually all the animals in a herd which die, perish in a single night, or, at the longest, within a few days after the first death occurs. It is generally believed to be invariably fatal, and its symptomatology has not been fully determined.

This affection of cattle has been known to exist for many years. The place and time of its origin, however, are not known, but it seems to be peculiar to the United States, and to have first appeared west of the Alleghany Mountains. Farmers tell us of its occurrence in the Mississippi Valley forty or more years ago. They usually refer to its extensive ravages in 1864-65, and again in 1868. From an historical

standpoint, no positive statements can be made concerning it prior to 1868, when the first recorded investigations into its nature and cause were made. After that time the disease seems to have escaped the attention of investigators until 1889, when Dr. Frank S. Billings, of the agricultural experiment station of Nebraska, published the results of his investigations. His "germ theory" and the wide distribution of his publications gave to this disease of cattle an unwarranted conspicuousness, and did much to direct attention to the malady, which he set forth as one of vast economic importance. This aroused the fears of cattle raisers, who depended in part or wholly upon corn fodder to winter their animals, and revived both the interest in this disease and the fear of it.

A careful review of the recorded statements shows that many causes have been assigned to it. The various theories have, for the greater part, been formulated by farmers, cattle raisers, and local veterinarians, and, as might be expected, they are based very largely upon the history of a limited number of outbreaks. A more careful inquiry into the origin of these theories shows that as the disease, with occasional exceptions, occurred in only one or two herds in a neighborhood during the same season, the local conditions affecting these herds were supposed to be favorable to the disease, if not its exciting cause. It would be useless to attempt a consideration of all the causes which have thus been suggested. There are, however, certain theories which appear to possess a greater or less degree of probability, and which can not be gainsaid without positive evidence to the contrary.

It is a curious fact that, while nearly every cattle owner in the sections where this disease prevails, in his experience, entertains one of the popular theories respecting its cause, the other supposed causes have proven to be erroneous or for other reasons are believed to be spurious. There is no uniformity of opinion concerning its etiology. The theories most commonly entertained are appended:

- (1) A lack of salt and an insufficient supply of water.
- (2) Feeding the cornstalks without an admixture of other food, such as hay, straw, grain, or pasture grass.
- (3) Impaction of the third stomach (omasum) due to overfeeding upon the dry cornstalks.
- (4) The ingestion of corn smut (*Ustilago maidis*).
- (5) A species of bacteria which is found in the lesion of a disease of corn known as "corn blight," or the Burrill disease.

The first three of these theories are of popular origin and are not supported by the general experience of cattle raisers, as will subsequently be shown. The "smut theory," which was somewhat strengthened by the report of Professor Gamgee in 1868-69, has many adherents. So firmly do certain farmers believe it to be the causative agent that they collect and draw out of the field all stalks affected with this fungus. The "germ theory," advanced by Billings, is believed in many

sections to be the true explanation of the cause of this malady. The stronghold which the last two theories have on the farmers and cattle raisers of the West, and the inconvenience and often expense involved in carrying out the methods of prevention indicated by them, render necessary a brief consideration of the facts upon which these theories are founded, in order that the results of the investigations here recorded may be understood and properly interpreted. As will be shown, our investigations, which would have verified these theories if they were true, fail to confirm the correctness of any of them.

INVESTIGATIONS PRIOR TO 1892.

THE INVESTIGATIONS OF PROF. JOHN GAMGEE.

In 1868 Gamgee was employed by the United States Department of Agriculture to investigate the cornstalk disease of cattle. Although this disease had been known to exist for many years prior to that time, its ravages had not been sufficiently extensive to enlist any active inquiry into its cause or means of prevention. The "smut theory" appears to have been the prevailing one at that time, and consequently Gamgee's report¹ deals almost exclusively with the effect of improperly prepared food, smuts, etc. Corn smut prevailed to an unusual extent in 1868, and in order to test its etiological value he carried out the following experiment:

Forty-two pounds of smut free from extraneous material were collected and fed to two cows, together with a small quantity of corn meal and as much cut hay as they could eat. The smut was mixed with corn meal and wet for one animal; the other received it in a dry condition. At first the cattle received 3 ounces of the smut twice daily, but later the quantity was increased to 12 ounces daily. The animal that received the wet meal and smut gained in flesh; the other lost in weight. They were apparently perfectly well at the time the experiment was completed.

The only conclusion which seems to be justified from this experiment is the one Gamgee himself drew, viz, "that smut is not a very active poison in combination with wholesome food." Although the experiment with smut failed to demonstrate any etiological value, he entertained the opinion that the smut and moldy corn were the causative agents in the production of the disease.

In his report a somewhat interesting description of the symptoms of this disease is given. Although the symptomatology is quite exhaustive the text is not clear on the point whether or not the symptoms were observed by himself or reported to him by the owners of the cattle. His description of the symptoms and pathological changes in animals affected with this malady is as follows:

Symptoms of the ill effects of smutty corn.—Cattle fed on smutty cornstalks first denote ill health by constipation. It is true that a farmer may be attracted only by an animal lying down, with an unthrifty look, staring coat, dry muzzle, and perhaps

¹Diseases of Cattle in the United States. U. S. Department of Agriculture, 1869, p. 73.

trembling; or a steer may be noticed "tucked up," with hind limbs drawn under, head depressed, shivering, dullness of eyes, and anxious expression of countenance. In the third variety the animal seems excited, breathes quickly, and is apparently somewhat delirious; indeed, in the condition described by Mr. Cumming, of Ellen, Aberdeenshire, resulting from impaction of the third stomach, as in cases of lead poisoning, nothing is more strange than this delirium, associated as it is sometimes with blindness. A farmer writing me from the West says that when he tried to put a rope around the head of a sick cow, which he found standing with all the symptoms of sickness presented by other animals of the herd which had been with her in the cornfields, she turned and fought furiously. I have seen an animal in this condition tied up in a stall, rush forward, plunge, strike against any obstacle, roar, moan, grunt in breathing, and appear to suffer acutely if touched or disturbed. In other words, with the impaction of the third stomach, which is the essential lesion of the disease, whether induced by smutty stalks, old indigestible stalks that have no smut, or other kind of food or poison, there are two distinct conditions induced—the one of stupor, listlessness, vertigo, and depression of spirits, indicated by the animals standing sullenly until they drop or are relieved; the second is a state of exquisite sensitiveness, a hyperæsthesia of the skin and system generally. The animals are not only excited, but in a state of actual suffering, and die very speedily in a state of coma or in convulsions. The disease does not last long. I have seen an animal linger on four or five days, but usually the whole course of the malady is run in twenty-four to forty-eight hours.

An animal first seems to show costiveness, with a dry mucus over the scanty excrement; and, although apparently undisturbed, and even feeding, may be dead in twelve to twenty-four hours.

The diagnosis of the disease at an early period of its manifestations is therefore important, and it rests on the knowledge of the manner in which animals have been treated and fed (as the simultaneous attack of several animals show), and especially on the observations of a fact that I have usually noticed, that the animals which have eaten most ravenously have been the first and most severely affected. Old cattle may sometimes avoid the smutty food, and young animals eat heartily; the latter will be found the only ones to die.

Post-mortem appearances.—The state of torpor of the alimentary canal of animals affected with this disease is indicated on opening the belly and exposing the stomach to view. In the first stomach, or paunch, corn husks and corn are found in a dry condition. Sometimes the rumen is very full, and gas may have become disengaged in it so as to cause great distention, which is relieved by puncture. The contents of the second stomach, or reticulum, are in the same condition as those of the first, though sometimes mixed with some fluid. The third stomach (manyplies or omasum) is firm, distended, and on being opened the food is found caked between folds, with marked impressions of the papillæ or little eminences which stud the mucus membrane. We find in almost all fevers a similar condition of the third stomach, and indeed in healthy animals it is that part of the digestive organs in which the food is most dry and packed preparatory for solution by the gastric juice and intestinal secretions. But there are other lesions associated with this "caking" of the food in the third stomach, in specific diseases, and its existence without these affords evidence of a primary form of impaction, which has received remarkable names, such as "staking," "bound," "fardel bound," etc. The fourth stomach contains but a scanty quantity of greenish, semidigested matter, is usually reddened somewhat diffusely, and the redness increases at times toward the opening of the small intestines.

The intestine, usually replete with somewhat solid and imperfectly digested food, is usually high colored, especially in the fundus of the cæcum and in the large portion of the colon. The rectum is the seat of ramified redness, and a consistent mucus coats its contents.

Persons have reported a peculiar black color of one lung. This is due only to stagnation of the blood after death in the organ nearest the ground, and the same kind of congestion or settling of the blood is apt to pervade other tissues and organs in the side on which the animal has been lying."

THE INVESTIGATIONS OF DR. F. S. BILLINGS.

In 1889 Billings described the cornstalk disease¹ as an "acute extra-organismal septicæmia, due to micro-organisms belonging to the class of ovoid-belted germs, to which variety of disease also belongs the swine plague, southern cattle plague, Wildseuche, hog cholera, and yellow fever in man."

In January and March, 1888, and in February, 1889, he had occasion to examine pieces of tissue brought from cattle that had died while feeding in cornstalk fields. In the first case the tissues were sent in an unsterilized bottle. From the bits of organs which he thus received he invariably isolated a bacillus which he affirms to be the cause of the disease.

The most interesting part of his investigations was the supposed discovery of the identity of the bacillus which he found in the animal tissues with the one described by Burrill² as the cause of a disease in cornstalks. This hypothesis is supported by the fact that by feeding the diseased stalks to a rabbit he produced a fatal disease and from the organs of the dead rabbit he obtained pure cultures of the bacillus. He sent a culture of his bacillus to Burrill, who stated that the organism which he (Billings) had obtained from the organs of dead cattle appeared to be identical with the bacillus which produced the disease in the cornstalks. The correspondence between these two investigators, published by Billings, shows that Burrill was conservative on this question, pointing out obvious resemblances only. The responsibility of the statement that the two bacilli are identical rests with Billings.

Dr. Billings found this micro-organism to be fatal to rabbits, guinea pigs, and mice, when inoculated with small quantities of a pure culture. A rabbit fed with a pure culture died in four days and pure cultures of the bacillus were obtained from each of the organs. A calf and a hog were inoculated subcutaneously with 6 c. c. of a pure bouillon culture. The hog remained well, but the calf became visibly affected. The temperature rose to 41.5° C. (106.7° F.). It became very much emaciated, but eventually recovered. Six days after the inoculation he obtained a pure culture of the bacillus from the blood which he drew from a vein at the root of the tail. In a subsequent experiment he inoculated a calf in the jugular vein with 9 c. c. of a pure culture of the bacillus. The calf died in two days. He also produced fatal results in one of two

¹Bulletin of the Agricultural Experiment Station of Nebraska, Nos. 7, 8, 9, and 10. Original Investigations of Cattle Disease in Nebraska, 1886-1889, University of Nebraska, 1889, p. 164.

²Proceedings of the Society for the Promotion of Agricultural Science, 1889, p. 19.

pigs by feeding them the viscera of the calf which died from the intra-jugular inoculation. The other pig sickened but recovered. From the dead pig pure cultures of the bacillus were obtained.

As would be expected, the pathology of the disease which he gives is extremely meager, owing to the fact that all the tissues he saw were brought to him in a few small bottles or jars. In a few cases they are said to have been much changed by decomposition. Nevertheless he found pneumonia to be one of the lesions characteristic of the disease, and in a subsequent bulletin¹ he places great importance upon this lesion, although he records very few additional observations to sustain the claim. In this publication, however, he attempts to show that chronic interstitial pneumonia in cattle is a sequel to the cornstalk disease. The argument is a confusion of statements from various English and French veterinarians which, for the greater part, appeared after the supposed discovery of cornstalk disease in American cattle at La Villette, France. The importance of lung lesions, which he emphasizes in his second bulletin, appears to have been suggested by the following incident, which temporarily gave to this disease an undue importance from a commercial standpoint:

In 1890 a few animals from a shipload of American cattle landed at La Villette, France, died of pneumonia. They were examined very carefully by Nocard and other French veterinarians. From the diseased lung Nocard obtained a microorganism which corresponded very closely to the description of the bacillus of the cornstalk disease of cattle in America, described by Billings. The publication² of this fact gave rise to a temporary supposition that this American cornstalk disease might be a menace to the cattle of Europe, and consequently initial steps were taken to require American cattle to be quarantined against it. The fact was subsequently determined that the bacillus isolated by Nocard was that of a form of bovine pneumonia occasionally met with in America, but not known to be contagious, and the matter was dropped.

The symptomatology as described by Billings is confined to the inoculation disease. These symptoms, however, are so confused with those of swine plague and Texas fever that they are not of diagnostic value.

In a recent popular publication³ Billings makes the following statements:

It is now six years since I first discovered a germ in cattle sick and dying from being turned into stalk fields. In many cases I have carefully examined the whole field, and in some of the worst outbreaks smut was most conspicuous by its almost total absence. Again, Gamgee reports that the manure of his cows, which ate 31 pounds each, was black. In all the autopsies I have made—and they run up to the

¹The Corn-Fodder Disease in Cattle and Other Farm Animals, etc. Bulletin Nos. 22 and 23 of the Agricultural Experiment Station of Nebraska, 1892.

²Nocard. Une Broncho-pneumonie infectieuse des Bœufs Américains. The Cornstalk Disease. *Recueil de Médecine Vétérinaire*. Tome VIII (1891), p. 424.

³Breeders' Gazette, Vol. XXVI, 1894, p. 340.

fifties—and among all the sick cattle I have seen there was not an indication of any discoloration of the manure unless it was abnormally light yellow in color. Not only in every case personally examined, but in still more where blood and organs have been sent me, have I isolated one and the same germ, but have repeatedly produced the disease in cattle with inoculations of pure cultures. Some six weeks since I received some corn from a field in which cattle were dying in Indiana, and in this corn I found the same germ. I inoculated rabbits with some small fragments of the diseased corn and it killed them, and from them I made pure cultures and injected 2 cubic centimeters into the jugulars of two cattle (2-year-olds) with the result of killing one and making the other very sick, getting the same germ from both.

So long as these people do not seek a germ in the cattle, so long as they ignore so much proof—and it must be remembered that the same germ has been found and proved in our cattle in France, and the same lesions reproduced by inoculation—so long have these men absolutely no right to advocate the smut theory.

He suggests as a means of prevention that all the diseased cornstalks should be destroyed and animals which die of the disease should be carefully buried or burned. The suggestion is also made that in order to detect the presence of the disease the temperature of the cattle should be taken each night, and all animals which give a temperature over 100° F. must be looked upon as suspicious and those in which it exceeds 102° F. as diseased.¹

INVESTIGATION AT THE ILLINOIS STATE EXPERIMENT STATION.

A single experiment was made at Champaign, Ill., in 1890, in which the etiological importance of corn smut was tested. A bacteriological examination of the organs from an animal that died in a cornstalk field, supposedly of this disease, was also made by Professor Burrill in 1889. A copy of the station experiment report, which I was told included all of the work which has been done on this disease at that place, was kindly furnished by Professor Morrow, with the privilege of publishing.

Experiment No. 98.—(Investigation of a disease which sometimes affects cattle when turned into cornstalk fields):

Mr. J. M. Craig reports a loss of nine yearlings as follows:

The first animal died two weeks before the cattle were turned into the stalks and while running on clover pasture. This animal was left where it died, and the cattle when turned into the stalk field had access to the pasture, but were believed by Mr. Craig not to have frequented it, and it was not thought that the first death had any connection with those that followed.

Mr. Craig turned twelve head of fattening cattle into a cornfield of 22 acres, which he estimated yielded 65 bushels per acre, on Sunday, probably November 24, 1889, and one steer died the Friday following. The remaining cattle were removed, and on the following Wednesday thirteen "stock" cattle were put in the field. Sunday five died, one died Monday, and one Tuesday night. The remaining cattle were then removed.

December 13, at the request of the experiment station Mr. Craig put the six head of cattle which survived again in the field.

¹It seems strange that such a statement as this should be made when standard German authorities give the normal temperature of cattle from 101° to 101.8° F. Dr. E. C. Schroeder, of this Bureau, who has had much experience in applying the tuberculin test for tuberculosis in cattle, finds that the normal temperature of cattle varies from 101° to 103° F.

December 26, one steer was reported sick. The animal was visited and found to be dull, pulse strong, regular, 56 per minute. Took sample of urine at 6.10 p. m., being the third passage in 30 minutes (Lab. No. 167). Urine afterwards passed as follows: 6.20, 6.25, 6.29, and 6.32.

December 20, three yearling steers were purchased by Mr. Craig and placed in the cornfield.

December 23, a steer was perfectly well the previous evening at sundown, but early in the morning it was unable to get up. At 10.30 a. m. the pulse was about 90, membranes pale, breathing 12 per minute. Dr. McIntosh decided that the animal was unable to live and had him killed. A post-mortem examination was made by Dr. McIntosh and every part pronounced normal except a slight exudation in the liver. Examinations and cultures from spleen, liver, etc., by Burrill failed to reveal any organisms.

The six head that were placed in the field December 13 were removed.

To ascertain whether the smut was responsible for the disease, about 60 pounds of it were collected and fed to a grade Jersey steer, with grain and hay as follows:

From December 13, 1889, to January 2, 1890, 120 pounds of grain, 105 pounds of hay, 20 pounds of smut, and 371 pounds of water were given. From January 2 to January 24, 1890, 176 pounds of grain, 135 pounds of hay, and 39 pounds of smut were fed and 366 pounds of water given. When the experiment was begun December 13, 1889, the steer weighed 560 pounds. January 2, 1890, he weighed 551 pounds, and January 24, 555 pounds. No evidence of disease was discovered.

A LETTER OF INQUIRY AND A SUMMARY OF THE REPLIES.

The absence of reliable data concerning the nature, distribution, and importance of this disease led to the issuing of a circular letter in 1891 to a large number of farmers and cattle raisers by Dr. D. E. Salmon, Chief of the Bureau, for the purpose of obtaining more extended information concerning this disease. Although the replies to the various questions in this letter can not be considered from a scientific point of view altogether accurate, they were given in good faith and indicate the ideas then entertained by interested parties concerning the nature of this disease. During the past few years, however, the "germ theory," as announced by Billings, has become better known through the publication of his results and is more generally accepted as the correct explanation of this mysterious disease. Furthermore, the replies received are important in showing the economic importance attached to this disease by those who suffer most from its ravages. The letter and a summary of the replies are appended:

WASHINGTON, D. C., *March 20, 1891.*

SPECIAL CORRESPONDENT OF THE BUREAU OF ANIMAL INDUSTRY, DEPARTMENT OF AGRICULTURE.

SIR: For many years cattle feeders and stockmen have recognized a disease which has caused extensive losses among their cattle in the fall of the year when the animals were turned into cornfields to feed upon stalks.

Various causes have been assigned for the trouble, such as smut, indigestion from the hard, woody nature of the stalks, and lack of nutriment in the leaves, lack of salt, insufficient supply of water, and a germ producing the so-called "cornstalk disease."

This Bureau contemplates entering upon an investigation into the nature of the malady, but before commencing the critical examination, for which material can not

be secured until next fall, we wish to collect information concerning the prevalence, symptoms, and other facts relating to the disease.

Accordingly this circular letter has been addressed to you as a special correspondent of the Bureau of Animal Industry with the hope that your experience will be a valuable aid to us in the investigation.

If those receiving this circular will promptly and as accurately as possible answer the questions on the opposite page they will confer a favor on the Bureau and assist in collecting information which may prove of great importance to the cattle industry of the United States.

A return envelope is inclosed, which can be used without the payment of postage.

Very respectfully,

D. E. SALMON, *Chief of Bureau.*

QUESTIONS.

(1) Have you or your neighbors ever lost cattle from turning them into cornstalk fields?

(2) How many cattle were turned into the fields and how many died?

(3) How were cattle fed before being turned into the cornstalk fields?

(4) How soon after they were turned into the stalk fields did any of the cattle die?

(5) How long before deaths ceased?

(6) What were the general symptoms of the disease?

(7) Did stock receive a liberal supply of salt and pure water?

(8) Did they receive any food in addition to the cornstalks?

(9) Have you noticed that some fields in the same neighborhood are more dangerous than others at the same time of year? If so, was there anything in the situation of the field or condition of the stalks to account for it?

(10) Have you observed any disease of the cornstalks in the fields where the cattle disease was contracted?

(11) Have any horses or other animals died from turning them into cornstalk fields?

(12) Is the disease becoming more frequent than formerly, or is it disappearing?

(13) Do you take any precautions for preventing the disease? If so, what are they, and what is your success?

There were received from the States of Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri a total of 634 replies to this letter, in which some or all of the questions were answered. Of these, 394 reported that either they or their neighbors lost cattle in cornstalk fields the preceding year. Sixty of these correspondents reported the disease in horses, and curiously enough 32 of them resided in the State of Kansas. Eight reported it in sheep, and 6 of these were from Kansas. The disease was not reported to occur in other animals.

A perusal of the replies to question 3 shows that the great majority of the affected cattle were on pasture land prior to turning them into the cornstalk fields.

The time that elapsed after turning the cattle into the cornstalks until death occurred is reported to be from four hours to two months. Of the 328 answers to the fourth question, 48 of them stated that death occurred in twenty-four hours; 59 in two days; 45 in three days; 23 in four days; 20 in five days; 13 in six days; 47 in seven days; 51 in from one to two weeks; 15 in three weeks; 5 in one month, and 5 in from one to two months. A few others indicated its occurrence in from four to eight hours.

The symptoms given were very numerous. Indigestion, bloating, constipation, "crazy," "stupid," and "dry murrain" were stated to be indications of the presence of the disease.

Fourteen outbreaks were reported to have occurred among cattle which were supplied with salt but no water; 35 outbreaks occurred where there was plenty of water but no salt. In 254 of the outbreaks reported there was an abundant supply of both water and salt, and in 123 outbreaks the cattle received neither salt nor water.

In answer to the question concerning food other than the cornstalks, 302 people replied that no other food was given, while 107 owners fed hay, straw, grain, or allowed the cattle to run at will in pasture or meadow land (usually meadow). The reply to this question was omitted in over 200 of the returned letters.

To the ninth question the answers were equally divided between yes and no. Some men stated that low ground was most dangerous, others that the disease occurred upon high ground most frequently. The presence of smut (*Ustilago maidis*) was the only abnormal condition of the cornstalks reported and was indicated in about one-third of the fields where the disease occurred.

The answers to the question whether the disease is becoming more frequent than formerly, or is disappearing, are interesting. Of those who replied to this question 115 stated that it was common, 50 stated that it was on the increase, while 264 wrote that it was decreasing, and a few others stated that there was no such disease.

Numerous methods for preventing the disease were indicated. Furnishing the animals with an abundance of salt and water and allowing them to remain in the stalk fields for only a short time each day during the first few days appear, however, to be the most common preventive methods. The removal of smut comes next. The fact that the disease appeared where these precautions were taken eliminates the desirability of considering them further than to point out the fact that thus far no efficient means of prevention has been adopted. A few of the customary preventive measures will be considered in connection with the outbreaks investigated.

SPECIAL INVESTIGATIONS.

METHODS.

The investigation into the nature and cause of this disease was attended with many difficulties. The facts that the disease appears at irregular intervals over a large territory, that there is no certainty of its appearing or recurring in any particular locality, that the affected animals are usually found dead, and that frequently all the deaths in an outbreak occur in a single day rendered the adoption of a method for procuring suitable material a matter of considerable difficulty. From the existing knowledge of the disease it was evident that laboratory work was quite as essential as post-mortems for the success of the

investigation. The conditions mentioned rendered necessary the adoption of some plan whereby notice of the occurrence of the disease could be received promptly and the affected herd visited in the shortest possible time. A careful consideration of these and other conditions necessary for this investigation led to the conclusion that some place within the infected district should be selected where the necessary laboratory facilities could be obtained, and from which it would be possible to reach the affected animals before it would be too late to make the desired observations.

In carrying out this plan arrangements were made with the authorities of the State experiment station at Ames, Iowa, whereby the use of their bacteriological laboratory was obtained. Further assistance was afforded by the cooperation of Drs. Stalker and Niles, of the veterinary department. Dr. Niles assisted in many of the post-mortems and in the laboratory work. Through the kindness of Professor Wilson, director of the station, a notice of the intended investigations was inserted in nearly all of the county papers and all of the agricultural journals of Iowa, requesting that notice of all outbreaks of this disease should be promptly sent to the State experiment station. About one hundred letters were also sent by the chief of the Bureau of Animal Industry to cattle raisers who had replied to the circular letter of the year before, asking them to report promptly any outbreak of cornstalk disease in their locality, as steps were being taken to inquire into its cause and means of prevention. Through these arrangements it seemed highly probable that the opportunity would be given, in view of the extensive losses previously reported, to make careful observations on a considerable number of affected animals both before and after death.

Notwithstanding these preparations, it was found to be impossible to receive notice of the appearance of the disease and to reach the infected herd before the disease was over and the dead animals in several instances advanced in post-mortem changes. The disease usually occurred from 100 to 300 miles from Ames, and as word was not sent until one or more deaths had occurred, and then by mail, it is evident that with the utmost promptness from one to four days must elapse after the time of the first death until the examination was made. It is a significant fact that in 1892-93 only one outbreak occurred near Ames, and in this instance one of the two animals that died was found dead and the other was sick but two hours. However, several outbreaks were visited, and post-mortem examinations were made on a number of animals within a few hours after death.

The method of investigation followed in 1892 was to make careful post-mortem examinations, to make a large number of cultures from the different organs of all the animals that were in a suitable condition, to preserve in alcohol or Müller's fluid pieces of the tissue for microscopic examination, and to take to the laboratory at Ames large pieces of the organs for microscopic study while they were in fresh

condition, and for additional cultures when deemed advisable. A large number of cover-glass preparations from the blood¹ and various organs were also made at the post-mortem, and subsequently stained and examined microscopically.

In 1893 Dr. F. L. Kilborne investigated several outbreaks of the disease in Iowa. He made the post-mortems, and sent cultures and tissues to the laboratory of the Bureau, where they were carefully examined. Although this method was attended with many disadvantages, it was in a measure quite satisfactory.

From the symptoms of this disease reported in 1892, the possibility of its being an affection of the nervous system resembling rabies to a certain extent was suggested. This theory was strengthened by the existence of a disease among cattle at Green, Iowa, in the fall of 1892, which could not be differentiated from rabies by the symptoms manifested or by rabbit inoculations, and in which a history of a dog bite could not be obtained. (See page 71.) The determination of this point by rabbit inoculations, the repetition of the bacteriological work, and the carrying out of certain feeding experiments for the purpose of testing the extent of the infection in the cornfields where the disease occurred were the lines of investigation followed in 1893.

The absence of recorded data on this disease has led to a somewhat detailed account of the conditions under which the various outbreaks occurred, and the appearances found upon post-mortem examination of certain of the animals. In the history of the outbreaks, as well as all facts relating to the individual animals prior to the post-mortem examinations, we must rely necessarily upon the statements of the owners who were carefully questioned concerning them.

OUTBREAK NO. 1.

This outbreak occurred on the farm of Mr. John Bixler, located about 3 miles west of Red Oak, Iowa. Mr. Bixler had about 70 animals (calves, cows, and steers) which had pastured on prairie land during the summer. About the 1st of November the cattle were turned into cornstalk and clover fields (20 acres of each). For the first six days they were allowed to remain daily in these fields one and one-half hours in the morning and the same time during the afternoon. After six days they were allowed to run in the cornstalk field, meadow, and pasture at will. It was observed, however, that they remained almost entirely in the cornstalk and clover fields. All the fields were on upland. The cattle had plenty of salt and well water.

November 11 the cattle were yarded for dehorning purposes, and each animal was noticed. They all appeared to be well. On the following

¹In addition to these, fresh preparations of blood were made and sealed, so that they could be examined microscopically before drying. It was found that white wax could be used with much success in sealing these mounts. Blood could be kept fresh for from eighteen to thirty hours by this plan.

morning a 2-year-old steer was found lying in a natural position, excepting the head which rested on the ground and moved continually from side to side. He could not be induced to get up. The frost on the grass showed that he had not floundered about. He remained in this position throughout the day and died early in the night.

November 14, the cattle were driven to water about 11 o'clock in the morning. A 2-year-old steer was observed to tarry behind the others. At 3 o'clock he was found lying in a dying condition. He was very much bloated, and died without struggling. No other cattle died, although they continued to run in the same fields. Notice of this outbreak was not received for three days after the last death had occurred. Owing to the fact that the animals had been skinned immediately after death, and that the temperature had been below freezing, the post-mortem changes were not so far advanced as would ordinarily be expected. They were examined November 18.

NO. 1 (STEER 2 YEARS OLD).

This animal had been dead five days and was much bloated. Brain appeared to be normal; no evidence of congestion. There was a slight pigmentation of the pia¹ over the frontal lobes. First and second stomachs were normal. Third stomach very hard; could be dented with the thumb only with difficulty; contents very dry; mucosa sloughed off (probably due to post-mortem changes). The mucosa of the true stomach deeply reddened in places, apparently due to blood extravasation. The mucosa of the duodenum and upper jejunum reddened, sprinkled with hemorrhagic areas, and covered with a muco-purulent substance. The edges of the folds of the mucosa in the caecum and colon also reddened. Rectum appeared to be normal. Liver, spleen, and kidneys discolored and soft, due largely to decomposition. Lymphatics normal. No hepatization of the lungs.

NO. 2 (STEER 2 YEARS OLD).

This animal had been dead nearly four days. He was bled while in a dying condition, and consequently the post-mortem changes were less advanced than in No. 1. The brain was pale; small amount of pigment over frontal lobes. The third stomach was firm; contents dry. The fourth stomach and intestines showed more intense congestion than in No. 1; no hemorrhages. Gall bladder contained considerable thick, viscid, greenish-yellow bile. Kidneys pale. Spleen and lymphatics appeared to be normal. Liver reddened; edges rounded. Lungs not diseased.

Bacteriological examination.—Cultures were made from steer No. 2 only. Tubes of agar were inoculated with pieces of the brain, liver, and kidney. The tubes inoculated from the kidney remained clear. The others developed into pure cultures of *Bacillus coli communis*. A rabbit inoculated subcutaneously with 0.5 c. c. of a bouillon culture remained well. This organism was studied carefully, but found to possess no properties unusual for the colon bacillus.

Cover-glass preparations were made from the various organs at the autopsy. Those made from the kidney and liver contained putrefactive bacteria. In other preparations no bacteria were discovered.

Microscopic examination.—No microscopic examination was made of the organs from No. 1. The brain, liver, and kidneys in No. 2, examined in a fresh condition, showed advanced post-mortem changes. There was an abnormal amount of blood

¹ This pigmentation is not uncommon in healthy cattle, as determined by the examination of the brains of a large number of animals slaughtered for beef.

in the liver, cell nuclei visible, cellular protoplasm granular. Epithelium of the kidneys granular. Stained sections of the liver from pieces hardened in alcohol exhibited a granular condition of the cells; the nuclei were broken up but their outline was unchanged. There were few free nuclei. In areas involving a variable number of lobules the intralobular capillaries were distended with blood, the liver cells being separated from each other. The blood engorgement was more intense in the inner zones of the lobules. In similar sections of the kidney a few of the capillaries were distended with blood. Epithelium granular (probably due to post-mortem changes).

In sections of both liver and kidney stained with aniline dyes a few putrefactive bacteria were observed.

OUTBREAK NO. 2.

Mr. E. E. Francis, residing near Wales, Iowa, lost one heifer in a cornstalk field. October 29 Mr. Francis turned 56 cattle in a cornstalk field for about two hours, when they were returned to the pasture. Thereafter the cattle were in the field continuously, and although they had access to a meadow they were observed to remain in the cornstalks most of the time. The corn was on upland. There was an unusually small amount of smut. The cattle had plenty of salt and well water. November 1, three days after the animals were turned into the cornstalk field, a heifer appeared to be dull, and the next morning she was found dead. She was examined by Mr. Francis, who found the rumen full and quite hard. No other lesions were noticed by him. The remaining cattle continued to run in the cornstalk field, but no other deaths occurred.

OUTBREAK NO. 3.

This outbreak occurred on a farm worked by Mr. L. W. Williams, located $3\frac{1}{2}$ miles from Ames, Iowa. Mr. Williams had 13 acres of corn. It was on upland with the exception of a low, tile-drained area of about one-fourth acre which was said to have been wet during the spring and early summer. On this area the corn was small, but was said to have had a good color. The corn throughout the field was thin (few stalks in each hill) and the stalks large. There was very little smut.

November 22, Mr. Williams turned seven cattle, all in good condition, into the cornstalk field. The herd was composed of two cows, one 3-year-old and four 2-year-old heifers. The cattle were left in the field all day, but yarded at night without food. They had plenty of well water, but no salt until November 26. For the first two days they had access to a millet field, after which they had no food other than the cornstalks. Prior to turning the cattle into this field they had been in a clover meadow. The animals did well and no ill effect was observed until November 27, when a 2-year-old heifer was found dead.

November 29, the 3-year-old heifer was apparently well at 5.30 a. m. About 7 o'clock she was found resting squarely on her knees, the head extended and resting on the ground. She was frothing at the mouth and groaning as if in great distress. Mr. Williams said that blood

oozed from the anus and vagina before death. She did not get up, dying about 9 a. m., two hours after she was first observed to be sick. The autopsies were made on both animals in the afternoon conjointly with Drs. Kilborne and Niles.

The remaining animals were kept out of the cornfield for a few days, after which they were returned without further loss. Mr. Williams had never before lost cattle with this disease, and so far as could be learned no other animals had died in that neighborhood while feeding in cornstalk fields.

Hogs which fed on the carcasses of the dead animals remained well.

NO. 3 (A 2-YEAR-OLD HEIFER).

This animal was found dead November 27; examined in the afternoon of November 28. The post-mortem changes were considerably advanced. The spleen was slightly enlarged; a blood clot between the spleen and the rumen extended over an area 4 by 6 inches in diameter. The stomach and intestines throughout appeared to be normal. No impaction of the third stomach. Fibrous tufts on the ental surface of the omentum reddened from capillary injection. Liver discolored by post-mortem changes; no hemorrhages observable. About 100 c.c. of clear, viscid, reddish-colored bile in the gall bladder. A few punctiform hemorrhages beneath the capsule of the kidney; the blood vessels of the cortex slightly injected. The bladder was empty. Lymphatic glands contained a few small hemorrhages. Lungs normal. Punctiform hemorrhages beneath the epicardium over both ventricles. No blood extravasations detected beneath the endocardium. Several hemorrhagic areas along the aorta. The brain was normal in color and consistency.

Bacteriological examination.—A tube of agar and one of bouillon were inoculated with small pieces of the liver, and a tube of agar was inoculated from the kidney. The tube inoculated with the kidney remained clear. Those inoculated with the liver developed into pure cultures of a micrococcus. It possessed no pathogenic properties as determined by rabbit inoculations.

Cover-glass preparations were made from the liver, spleen, kidneys, and blood. Those made from the spleen showed, when properly stained, putrefactive bacteria. No bacteria could be detected in the others.

Microscopic examination.—The changes that had taken place in the tissues after death were so well marked that examinations were made of the kidney and liver only in the fresh condition. The parenchymatous tissue was granular, nuclei not distinct. In sections cut by the paraffin method the kidney exhibited no well-marked abnormal change. The nuclei of the tubular epithelium were quite distinct, but the cells were slightly swollen, and their free surfaces somewhat broken; the outline remained intact. The intralobular blood spaces were filled with blood.

NO. 4 (A 3-YEAR OLD HEIFER).

The examination was made about four hours after death. The animal had been skinned, but the internal organs were not cold. Considerably bloated, said to be post-mortem.

The spleen was enlarged to fully twice its normal size. Hemorrhage between capsule and peritoneum extending over irregular areas, covering about one-third of the entire ental surface of the organ; pulp soft and of a uniform deep-red color; malpighian bodies were visible.

There was considerable light straw-colored oedema about the peritoneal attachments of the liver, the adjacent coils of the duodenum, and the gall bladder. The liver was much enlarged; edges rounded. The entire surface was mottled with purplish-black hemorrhagic areas varying from 1 to 10 mm. in diameter; frequently

they were confluent. The intervening area was of a deep reddish color mottled with hemorrhagic infarcts varying from 1 to 6 mm. in diameter. Acini indistinct; parenchyma easily broken down. About 200 c. c. of a clear, not viscid, greenish-yellow bile. Beneath the mucosa of the gall bladder were several small areas of blood extravasation.

The kidneys were slightly enlarged; beneath the capsule there were a considerable number of punctiform hemorrhages. Capsule normal. Cortex thickened and the blood vessels injected; medullary portion apparently normal. Considerable hemorrhage between the kidney tissue proper and the connective tissue of the pelvis.

The contents and conditions of the mucosa of the rumen and reticulum normal. The contents of the omasum unusually soft. Mucosa normal. The mucosa over a few of the folds of the abomasum congested, otherwise normal. In the duodenum extending from the stomach for a distance of 3 to 4 feet the mucosa was sprinkled with punctiform hemorrhages, likewise similar areas in the jejunum. In the ileum and caecum were several areas of congestion. Colon and rectum normal. Small blood clots in the uterus. Bladder empty. The mesenteric glands have hemorrhagic areas usually in the cortex, but in a few the medullary portion was involved. Lungs normal.

Heart of normal size. The blood vessels of the epicardium injected and blood extravasations along the course of the vessels which give the heart muscle a reddish (bloody) appearance. In the adventitia of the aorta were a large number of blood extravasations. These extended at irregular intervals from the heart to the diaphragm. The extravasations were more numerous over the auricles, beneath the endocardium, a large number of blood extravasations varying from mere points to areas a centimeter in diameter, many of them confluent. In the right ventricle extravasations covered about four-fifths of the entire surface. In the left ventricle a considerable area of its endocardium and auricle was hemorrhagic. Upon section the heart muscle of the right ventricle was found to be hemorrhagic for nearly one-third of its thickness, and in a few areas it extended entirely through the ventricular wall. A considerable number of blood extravasations in the muscles of the left ventricle. Several areas of the endocardium were of a grayish color. The blood in the heart and aorta was dark and firmly clotted.

Considerable hemorrhage was found over about four-fifths of the surface of the cerebellum and extending down between the cerebellum and cerebrum. The blood was between the pia and the brain substance. The blood vessels over the cerebrum were deeply injected; no hemorrhage. On section blood oozed from the cut ends of the smaller blood vessels.

Bacteriological examination.—Tubes of agar and those of either bouillon or glycerin-agar were inoculated, at the time of the examination, from the blood, brain, liver, spleen, kidney, and heart muscle. Large pieces of the various organs were taken to the laboratory in sterilized jars. From these, duplicate cultures were made on the following morning.

The cultures made from the liver, spleen, kidney, and one or more of those made from each of the other organs remained clear for several weeks, during which time they were shipped from Ames, Iowa, to Washington, D. C. Subsequently a few of them developed cultures of various species of saprophytic bacteria. The tubes of agar inoculated with the heart muscle, the blood, and brain developed into cultures of various bacteria within three days. The culture from the blood was impure. By means of agar plates two bacilli were isolated and subsequently carefully studied. They possessed no pathogenic properties and resembled in their cultural characters ordinarily observed saprophytic organisms. The agar tube inoculated with the heart muscle contained a pure culture of a nonpathogenic motile bacillus. The agar culture from the brain contained a streptococcus.

The agar culture from the kidney developed after several weeks into a pure culture of a motile bacillus. It was carefully studied, but found to be of no pathogenic importance as far as could be determined by inoculations into experimental animals.

A large number of cover-glass preparations were made from each of the organs and subsequently stained by various methods for the purpose of demonstrating bacteria, but with negative results. The subsequent examination of sections of the various tissues preserved in alcohol and stained for bacteria gave similar results.

Microscopic examination.—Sections and teased preparations of all of the organs of this animal were examined in a fresh condition. The nearness of the animal to the laboratory rendered this examination unusually favorable. The lesions discovered, however, were very slight. The liver cells were usually somewhat granular, and surrounded by a large number of red blood corpuscles, which filled the intralobular blood spaces. The nuclei were visible but broken up, giving to each the appearance of an area more or less thickly sprinkled with deeply stained points. Changes could not be detected in the interlobular tissue. The spleen, lymphatics, and brain did not show abnormal changes in the cellular elements. The blood was very carefully examined in fresh preparations. The corpuscles appeared to be normal. In the stained sections of the organs preserved in alcohol and Müller's fluid and cut by the paraffin method the engorgement and rupture of the blood vessels (capillaries) was more distinct. In the liver and heart muscle this was especially well marked. In the liver the blood engorgement was intense in the central zone of the lobule. The outlines of the nuclei were not altered. In certain limited areas free nuclei were observed.

The parenchyma of the kidneys appeared to be normal. In certain limited areas the capillaries were distended with blood.

In the heart muscle the capillaries were injected about the hemorrhagic areas. The normal markings of the heart muscle in the thin areas were not effaced, the lesions being confined to the capillaries.

OUTBREAK NO. 4.

This outbreak occurred on the farm of Mr. S. P. Miller, who resided about 5 miles northeast of Red Oak. Mr. Miller had 14 acres of corn, all on high land. The corn was good, but there was considerable smut.

Mr. Miller stated that on November 15 he turned 24 cattle, mostly calves 4 to 7 months old, into the cornstalk field. For several weeks prior to this they had been on clover pasture. For the first three days the cattle were allowed to remain in the cornstalks for about three hours daily. They received salt once a week and were supplied with plenty of fresh well water. They were allowed to run at will in a clover meadow adjoining the cornstalk field and appeared to do well for eight days when they began to die.

November 23, eight days after the cattle were turned into the cornstalk field a calf was found dead and much bloated, with froth about the mouth and nose.

November 24, a yearling was found dead. It had taken water twice and appeared perfectly well the day before.

November 26, a calf was found unable to get up. It appeared to be stiff and could move only with difficulty. It appeared to suffer very much; head down and eyes rolled up. It kicked considerably, and was shot in the afternoon to relieve its suffering.

November 29, a calf was found sick in the morning. It appeared to be "crazy," butted its head against boxes, and made desperate efforts to get out of the barn. It laid down in the forenoon and could not

get up. A part of the time it remained quiet, but at times it kicked and bellowed as if in great distress. In the afternoon there was a normal passage of the bowels. It ate nothing. At night it was killed by a blow on the head to relieve its suffering.

After the death of the fourth animal the remaining cattle were taken out of the cornstalk field and turned into a similar field on the opposite side of the road, where they remained well. Several horses were left in the infected field, none of which took the disease. Word was received of this outbreak at Ames November 28. November 30 we made an examination of these animals, but owing to warm weather the post-mortem changes were too far advanced in all but the last to make examinations of any value except to determine that the lungs were not hepatized.

NO. 5 (A CALF 7 MONTHS OLD).

It had been dead about fourteen hours and was considerably bloated, but in good condition. The post-mortem changes were slight. The capsule of the spleen was apparently slightly thickened; pulp soft. The capsules and size of the kidneys were normal; cortex reddened, due to injection of blood vessels. Considerable blood escaped from the small vessels on section. About 750 c. c. of cloudy urine in the bladder. Liver of normal size. Centers of the acini of a deep reddish color; periphery pale. Considerable blood escaped on section. Interlobular tissue apparently normal. About 100 c. c. of clear, dark, viscid bile in gall bladder. Contents and mucosa of the first, second, and third stomachs normal. The contents of the omasum dry, but not impacted. The blood vessels in the duodenum were injected in areas for a distance of about 4 feet. Mucosa of the ileum deeply reddened; contents normal. In the mucosa of the caecum, colon, and rectum were areas in which the blood vessels were deeply injected; contents normal. Lymphatics normal. Heart and lungs normal. Brain not examined on account of injury produced in killing the animal.

Bacteriological examination.—Tubes of agar were inoculated with small pieces of the liver, spleen, and kidney, and with several loops of the heart blood. About 20 c. c. of the blood were taken from the heart by means of a sterile pipette and transferred to a sterile cotton-plugged tube. It remained sterile. The tubes of agar inoculated with the spleen developed into pure cultures of a motile bacillus. One of the tubes inoculated with the blood developed into a pure culture of a motile bacillus belonging to another species. These bacilli were carefully studied and found to produce no pathogenic effect on rabbits. The other tubes of media inoculated from this animal remained clear.

A large number of cover-glass preparations from the different organs and blood were made. They were carefully stained and examined, but no bacteria or other microorganisms were discovered. The same results were obtained from sections of the kidney and liver stained for bacteria.

Microscopic examination.—Before it was possible to reach the laboratory the tissues taken from this case were too much decomposed for examination. The sections of the kidney and liver from pieces of those organs preserved in alcohol and Müller's fluid were carefully stained and examined. The kidney showed a slight injection of the capillaries in circumscribed areas. The liver showed in certain areas extensive engorgement of the intralobular blood spaces. In these spaces were a few free nuclei, and the liver cells were separated from each other. No appreciable change of the interlobular connective tissue. The spleen appeared to be normal.

OUTBREAK NO. 5.

This outbreak occurred on the farm of Mr. C. Johnson, of Tyner. He had two fields of corn. One of them contained 10 acres of upland and 2 acres of rather low, moist ground, and the other contained 45 acres of upland and 15 acres of low, wet ground. The corn on all the upland was very good; that on the lowland was "snapped" early in the fall and fed to cattle in the feed yard, all of which remained well.

October 31, 1892, Mr. Johnson turned 22 cattle into the 12-acre cornstalk field. Prior to this the cattle had been on pasture land. Before turning them into this field they were all dehorned. On the morning of November 1 a steer was found dead. The cause of death in this animal was attributed to the dehorning the night before, as the hemorrhage was extensive and the weather severe. No other deaths occurred while the cattle remained in this field.

November 19, the cattle were turned from the 12-acre field, together with 10 horses, into the 60-acre cornstalk field.

November 20, a 3-year-old heifer and a yearling steer were found dead. Both of these animals appeared well the night before.

November 25, two cows and two steers were found dead. One of the steers appeared to be "crazy and blind" the night before. The ground about the dead animals showed that they had rubbed their heads to and fro on the ground and that one of them had struggled considerably. Two of these animals were examined by a butcher, who stated that "the blood was a little dark, otherwise there was no disease." Mr. Johnson opened the heart and found dark colored clots of blood.

November 25 to 27, the remaining cattle were kept out of the cornstalk field.

November 28, they were allowed in the cornstalk field for about three hours.

November 29, they were in the cornstalk field all day.

November 30, a 3-year-old heifer which appeared to be well early in the morning was found lying down about 7 o'clock and unable to get up. She bellowed and kicked a great deal. When quiet, the legs were extended from the body and the tongue protruded from the mouth. She died two hours later.

Notice of this outbreak was received at the experiment station at Ames, December 1. In company with Dr. W. B. Niles I made a post-mortem examination on the dead animal (last to die), and carefully inspected the cornfield in the afternoon of the following day. Nothing was found to arouse suspicion. Arrangements were made with Mr. Johnson by which a feeding experiment in the infected field with other cattle could be made, but unforeseen incidents prevented the carrying out of this plan.

Mr. Johnson kept his cows out of this field for some days, when they were returned without further loss.

NO. 6 (A 3-YEAR-OLD HEIFER).

This animal was examined about thirty hours after death. The organs were badly decomposed. The normal markings were for the greater part entirely effaced. There was no evidence discernible of ante-mortem changes in any of the organs. The third stomach was rather soft; feces in the rectum of normal consistency. The lungs reddened; no hepatization. Brain normal in color, but quite soft.

There were 10 horses, all of which remained well, in the cornstalk field with the cattle. Hogs which fed upon the carcasses of the dead animals remained well. The facts that the "snapped" corn was fed to fattening cattle without producing any disturbance would indicate that the death of the animals was not due to feeding upon the few nubbins of corn that were inadvertently left in the field. It was observed by Mr. Johnson that the cattle fed largely on the cornstalks on the lowland.

A large bundle of the stalks, mostly leaves, was collected from the low ground and sent to the laboratory of the Bureau for a chemical analysis and for feeding rabbits. (See page 42.)

OUTBREAK NO. 6.

Mr. Robert Johnson, residing about 4 miles from Mechanicsville, lost two steers after turning them into a cornstalk field. A few others were sick, but recovered. The history of the outbreak, as given by Mr. Johnson, is as follows:

Thirty-seven cattle, a flock of sheep, and six horses were fed on cut cornstalks from about the 1st of October until the middle of November. At that time all of the animals were turned into a small (3-acre) cornstalk field. They had plenty of salt and well water. The stalks were soon devoured, after which the animals were fed on cut cornstalks and tame hay.

In about five days after the cattle were turned into the cornstalk field, but while they were still feeding upon the standing cornstalks, two steers were taken sick and died in four days.¹

While sick the steers ate with difficulty, frothed at the mouth, appeared to have sore mouths and eyes, and lost flesh rapidly. They exhibited no "crazy" symptoms.

November 21 a carload of the cattle was shipped to Chicago. Upon inspection at the stock yards one of the animals was rejected on account of its being "gaunt," but was sold to other parties. Soon after this two yearlings and a cow that were purchased and turned in with the remaining cattle were taken sick. They manifested the same symptoms but to a less degree than those which had perished. When examined, December 3, they appeared to have fully recovered. The horses and sheep remained well.

¹It is highly probable that these cattle died from some affection other than the cornstalk disease.

OUTBREAK NO. 7.

This outbreak occurred on a farm worked by Mr. Michael Cosgrove, located about 7 miles east of Toledo, Iowa. Word of this outbreak was not received until several days after the last animal had died, so that post-mortem examinations were not made. The following facts concerning the cattle were obtained from the owner:

The last of October, 21 cattle were turned into a cornstalk field. They remained well while in this field. November 18 they, together with 6 horses, were turned into a cornstalk field of 30 acres, mostly upland. They were in the field for only a few hours each day for the first five to eight days; the balance of the time they were on pasture land. They had plenty of salt, and well water was kept continually within their reach.

November 27 a cow was found down and unable to get up. She died during the following night. During the next forty-eight hours two other animals died, after an illness of about twelve hours each. Each of the affected animals appeared to be in much distress.

The horses remained well.

The crop of corn was good. There was considerable smut, all of which was picked and drawn out of the field when the corn was gathered. In 1891 four steers were said to have died of this disease while in the cornstalk field on the same ground. Mr. Cosgrove believed that the smut was the cause of the disease, and hence the precaution taken in 1892.

OUTBREAK NO. 8.

Mr. C. N. Heberlee, of Stewart, lost five cattle in cornstalk fields during the fall and early winter. The history of the outbreak, as given by Mr. Heberlee, is as follows:

About November 10, 1892, 25 cattle, mostly yearlings, were turned into a 15-acre cornstalk field. For the first few days they were in the cornstalks for only a few hours each day, but later they were left in them continuously.

November 25, the cattle were transferred to a 20-acre cornstalk field. Both of the fields were on upland. There was a moderate amount of smut on the corn. The cattle obtained water from a small stream which ran through an adjacent field (creek bottom). Rye had been sown in the cornfield, which gave a considerable amount of green food. The cattle had not been salted since they were turned into the cornstalks.

December 1, three steers were found dead. They were last seen November 29, when they appeared to be well. They were examined by Dr. Kilborne December 1, 1892. Owing to mild weather decomposition was well advanced, and little could be learned of the pathological changes. The contents of the third stomach were soft. The mucosa of the duodenum in each case contained areas of deep congestion. The lungs were not hepatized. All markings of the liver and kidneys were effaced.

December 2, another steer (No. 7) was found down and unable to get up. It groaned frequently and died about 10 a. m. Later in the day another steer (No. 8) was found dead. He had evidently been dead for sometime. Both of the animals were examined by Dr. Kilborne in the afternoon of December 2.

NO. 7 (A YEARLING STEER).

This animal had been dead but a few hours and was in good condition, not bloated. The spleen was not enlarged; pulp firm. On the ental surface there were about twenty deeply stained fibrous tufts, similar to those found on the omentum in cases of Texas fever. Malpighian bodies distinct. Liver swollen, deeply congested, giving it a dark-red color. On section the acini appeared with dark-red centers with lighter peripheries. Gall bladder contained about 100 c. c. of clear, viscid bile. The cortex of the kidneys was pale; medullary portion apparently normal. The mucosa of the bladder was sprinkled with punctiform hemorrhages. The bladder contained about 1,500 c. c. of clear urine, which was found to contain a small amount of albumin.

The first three stomachs were normal. The mucosa of the abomasum and areas in the duodenum and jejunum were congested. Ileum was filled with a pasty substance for about 8 feet from the lower end. The mucosa hemorrhagic. The membrane of the cæcum, colon, and rectum deeply congested. Contents rather dry. Lymphatics œdematous, not congested. Lungs normal. Numerous blood extravasations beneath the epicardium over both ventricles. A few hemorrhages beneath the endocardium in the right ventricle; in left ventricle a large hemorrhagic area. Heart empty. Small hemorrhagic points observed in the subcutaneous tissue, especially in the axilla and groins.

Bacteriological examination.—Cover-glass preparations were made from the blood, liver, kidney, and spleen. They showed no bacteria. Tubes of agar and bouillon were inoculated with pieces of the spleen and liver and remained clear.

Microscopic examination.—No examination was made of the fresh tissues. Pieces of the liver, spleen, kidney, and thigh muscles were preserved in Müller's fluid and alcohol. Sections of these organs cut by the paraffin method were carefully examined. Those of muscle and spleen showed no abnormal changes. A few of the capillaries in the cortex of the kidney were distended with blood. The tubular epithelium normal. The intralobular blood spaces in the liver were distended with blood. The engorgement was more general than in the previous cases. Liver cells separated and a few free nuclei. In many cells the nuclei presented small, deeply stained points separated by unstained portions. The outline of the nuclei not changed. There was considerable destruction of the liver cells in the central zone of some of the lobules.

NO. 8 (A YEARLING STEER).

This animal was bloated; post-mortem changes well advanced. Considerable straw-colored œdema in connective tissue surrounding gall bladder. Mucosa of the fourth stomach (abomasum) deeply congested. The mucosa of the intestines appeared to be normal. In other respects the lesions, so far as they could be determined, were not different from those in No. 7. On account of decomposition cultures were not made and none of the tissues preserved for microscopic examination.

OUTBREAK NO. 9.

Mr. John G. Jones, of Wales, lost three young animals in cornstalk fields in November. When visited the cattle had been dead for several days and consequently a post-mortem examination was not made. The data concerning the management of the cattle, as detailed by Mr. Jones, is as follows:

The first week in November, 40 head of cattle were turned into a 10-acre cornstalk field. They were allowed to remain in the cornstalks a few hours only each day for the first few days. They had access to a 20-acre clover meadow, and were yarded at night. They received salt twice a week and well water every night and morning. The corn in this and the subsequent field into which the cattle were turned was on high, rolling, prairie land. The growth of the corn was good. There was a small amount of smut. About November 16 the cattle were transferred to a second cornstalk field, which contained 20 acres, all on upland. While in this field they received no food other than cornstalks. They were yarded at night as before.

November 23, about 5 p. m., a steer was found to be sick. He stood apart from the others. About an hour later an effort was made to get him into a shed, when he fell down and could not be induced to get up. He remained quiet until about 8 p. m., when he died, three hours after he was first known to be sick.

November 24 the cattle were all apparently well when they were turned into the field at 9 a. m. At 2 p. m. a steer was found sick. It died in about two hours.

November 25 the cattle appeared to be well when yarded at night. The following morning (November 26) a yearling heifer was found unable to raise her head from the ground, apparently in a semicomatose condition. She remained in this condition until death occurred some hours later. None of the cattle bloated before death.

The remaining cattle were kept out of the cornstalks on November 27 and 28, but they were returned November 29. No death occurred subsequently.

Four years before (1888) Mr. Jones stated that he lost 4 or 5 animals in cornstalk fields, and about eight years prior to that he lost 8 animals from the same cause.

OUTBREAK NO. 10.

Mr. David G. Jones, who lived on a farm adjoining that of Mr. J. G. Jones (Outbreak No. 9), lost 2 animals in a cornstalk field. The absence of the owner rendered it impossible to obtain a complete history of this outbreak. As near as could be learned 15 cattle were turned into a cornstalk field about November 18. November 24 a 2-year-old steer died. November 30 a yearling steer died about 6 p. m. It was examined by Dr. Kilborne on the afternoon of December 1, about eighteen hours after death.

NO. 9 (A YEARLING STEER).

The spleen was dark colored, not enlarged, pulp soft. The surface of the liver was mottled with irregular branching, yellowish areas. The same condition was found upon section. The remainder of the liver was of a deep reddish color; acini indistinct; gall bladder empty. The cortex of the kidney was congested; no blood extravasation. About 100 c. c. of apparently normal urine in the bladder.

The mucosa of the first and second stomachs was unusually dark; contents normal. Third stomach contents rather dry, but not impacted. The mucosa of the true stomach deeply congested. The mucosa and contents of the duodenum and jejunum normal. In the lower 3 feet of the ileum the contents were blood stained and the mucosa was deeply reddened, due to the injection of the capillaries; contents normal. Colon and rectum normal. There were extensive blood extravasations beneath the epicardium of both ventricles and beneath the endocardium in the left ventricle of the heart. A small number of ecchymoses in the right ventricle.

Bacteriological examination.—Owing to an accident, cultures were not made from this animal. Cover-glass preparations from the blood, spleen, liver, and kidneys showed no bacteria.

OUTBREAK NO. 11.

This outbreak occurred on the farm of Mr. Tubbs, located a few miles from Emerson. It was learned at Emerson that the cattle had been dead for several days. This fact, together with the presence of a severe storm and deep snow, prevented a visit to the affected herd. The more general facts concerning the condition under which the outbreak occurred and the extent of the loss sustained were obtained from Mr. Tubbs, sr., who resided at Emerson.

About November 24, 140 cattle were turned into a cornstalk field of 65 acres. December 2, eight days later, 10 2-year-old steers were found dead. They were not known to have been sick. The remaining 130 animals were removed to a meadow, where 3 others died the following day. No more deaths occurred. The cattle were not returned to this field. The corn was good and situated on upland. There was very little smut.

About twenty-two years before Mr. Tubbs, sr., lost 20 animals in cornstalk fields. He had observed that the disease was most prevalent during dry seasons, and that snow or rain checked the progress of the disease. This opinion was entertained by veterinarians in that vicinity.

Mr. Tubbs reported that a neighbor, Mr. W. K. Post, lost 4 animals out of a herd of 33 which were turned into a cornstalk field. The deaths occurred on the eighth and ninth days after the cattle were turned into the field. Six young horses were pastured in the field with the cattle. The horses and the remaining cattle were kept continually in the cornstalk field, but no other deaths occurred.

OUTBREAK NO. 12.

This outbreak occurred on the farm of Mr. C. W. Hunt, of Woodbine. Although Mr. Hunt was visited by Dr. Kilborne immediately after receiving notice of the presence of the disease among his cattle, it was found upon arrival that no deaths had occurred for several days. Mr. Hunt's account of the symptoms observed in the affected animals, together with his statement concerning the condition of cornstalks and his method of managing the cattle, are unusually interesting.

During the first week of November, 33 cattle were turned into a cornstalk field of 20 acres. For the first three days the cattle were in the

cornstalks daily for two, three, and four hours, respectively. Afterwards they were in the field continuously. In about a week 2 steers were found dead. The remaining animals were left in the field until December 7, when they were transferred to a second cornstalk field. December 11 the same cattle were turned into a third cornstalk field containing 20 acres.

December 12 a steer was taken sick about 2 p. m. He laid down but could not get up. He remained quiet and was alive at dark, but was found dead on the morning of December 13, together with another steer which appeared to be well the night before.

December 13 a steer was observed to stop very suddenly and begin to tremble; muscles twitched and jerked. It soon laid down, and died in about an hour.

The symptoms generally appeared to Mr. Hunt to resemble those produced in a dog by an overdose of strychnine.

The cornfields were on high ground and all the corn was good. In the first two fields there was considerable smut and in the third a very large quantity. The cattle were watered from a running stream that passed through the place.

Mr. Beebe, a neighbor of Mr. Hunt, stated that he had lost three cattle in a cornstalk field. They died in about one week after being turned into the cornstalks.

OUTBREAK NO. 13.¹

This outbreak occurred near Van Meter, Iowa. Mr. A. B. McCleary purchased the standing cornstalks in two adjacent cornfields, containing 25 and 20 acres, respectively. They were on high ground. October 27, Mr. McCleary turned 35 cattle, mostly 2-year-old steers, into the 25-acre field. The cattle had free access to salt, which was kept continuously in an adjacent yard. They obtained drinking water from a small stream which passed along one side of these fields. The cattle were allowed to remain in the field continuously until November 26, when they were turned into the adjacent field. They also had free access to the first field, and obtained salt and water as before. The growth of the corn was much better in the second field than in the first. The soil was apparently identical, and the difference in the growth of the corn was attributed to the effect of the previous crops. In the first field the corn crop was preceded by oats and in the second field by clover meadow. There was a moderate amount of smut on the corn in both fields.

November 28, two days after the cattle were turned into the second field, a steer was found dead.

Early in the morning of November 29, 2 steers were found lying down and unable to rise. About 11 a. m., 2 others were found to be sick, and

¹ The field notes on this and subsequent outbreaks were made by Dr. F. L. Kilborne in the fall of 1893.

in a short time were unable to stand. One of the first affected was found dead at noon. The other 3 died before 2 p. m. Between 11 a. m. and 12 m. Mr. McCleary transferred the remaining 30 steers to the stock yard of his father, about 1 mile distant. About 1 p. m. the sixth steer was taken sick in the stock yard and died in about six hours. At 5 p. m. a seventh steer (No. 10 examined) was taken sick and died within two hours.

November 30 a steer (No. 11 examined) was found dead at 5 p. m., and it had evidently been dead but a short time. It was apparently as well as usual at 11 o'clock the night before.

Five colts, 2 and 3 years old, were in the cornstalk field with the cattle, but they remained well and were left in the field for three or four weeks after the cattle were removed.

The symptoms were closely observed in this outbreak by Mr. McCleary, his father, and two brothers, and also by a local veterinary practitioner.

The affected animals were quiet and stood with the head down. If forced to move they walked with jerky movements, especially of the hind limbs. In one case a steer showed a marked desire to press his head against the side of the stable, where he stood until he fell and was unable to rise.

Soon after the attack the animals showed marked weakness, especially in the knees, causing them to stagger if they tried to walk. After a variable time they would fall on their knees, shake the head, and either rise with some difficulty or fall completely down. Often two or three efforts to rise would be required before succeeding.

Following the first symptoms of weakness, they shivered or trembled "as if suffering from a chill." They were not feverish to the touch. Dribbling of the urine occurred while the animals were staggering about just before falling.

After falling down and getting up a few times they would fall on one side, unable to rise, and stretch out at full length, with the head thrown backward. Respiration was accompanied by "groans," as if the animals were in great distress. More or less saliva escaped from the mouth after the animals fell. The limbs and head, but especially the former, moved continuously backward and forward. No excitement or other nervous symptoms were noticed in this herd. The animals began to bloat soon after death.

The most reliable account of a recovery which we have from an attack of the cornstalk disease occurred in this outbreak. A steer was taken sick about 2 p. m., November 29, with the same symptoms as those manifested by the animals which died. He had difficulty in walking and trembled violently for a short time, when he fell. After ten or fifteen minutes he succeeded in getting up. He staggered about for a short time, when he began to improve and made a rapid recovery.

November 30, post-mortem examinations were made on two of these animals.

No. 10 (A 2-YEAR-OLD STEER).

This animal had been dead for about twelve hours when examined. Post-mortem changes were well marked. The rumen was distended with gas. Spleen considerably engorged, the pulp soft, and the normal markings were barely visible. There was considerable blood extravasation beneath the capsule.

Liver congested; surface, especially around the border, mottled with deep-red points. The acini, especially as seen on section, were distinct; the central portion exhibited a dark-red color; the peripheral portion was quite pale. Bile of a dark-greenish color and normal consistency. Kidneys apparently normal; urine cloudy. The first three stomachs normal in appearance. In the true stomach the mucosa was hyperæmic and sprinkled with numerous petechiæ. Intestines apparently normal. Lungs normal. Numerous points of blood extravasation beneath the epicardium. A few ecchymoses beneath endocardium of both ventricles. Both ventricles were filled with blood clots. Brain somewhat softened, otherwise normal.

Bacteriological examination.—Tubes of agar and glycerin agar were inoculated with pieces of the spleen, liver, kidney, brain, and several loops of the blood. The tubes of glycerin agar inoculated with the spleen and blood, and the agar tube inoculated with the liver developed into pure cultures of a micrococcus. The other tubes that were inoculated from this animal remained clear. The micrococcus was found to possess no pathogenic properties as indicated by intravenous inoculation of a large quantity of a pure culture into a rabbit.

Cover-glass preparations were made from the different organs and tissues at the autopsy. They did not reveal the presence of any bacteria. The same is true of sections of the organs preserved in alcohol.

The brain was placed in pure glycerin and shipped by express to the laboratory, where it was received three days later. Several rabbits were inoculated beneath the dura with from one to three drops of a suspension of the brain substance in sterilized distilled water. The inoculation wound healed rapidly and the rabbits remained well.

No. 11 (A 2-YEAR-OLD STEER).

This animal had been dead about thirty hours and had already been opened by Mr. McCleary and the intestines and stomach removed. The decomposition was somewhat advanced. The liver was deeply congested and presented acini with dark centers and pale periphery, as in No. 10. The capsule of the spleen was dotted with several pyriform hemorrhages. Pulp very soft and almost black (probably post-mortem). Brain substance of normal consistency, a considerable quantity of semiclotting blood surrounding the cerebellum beneath pia. A few punctiform hemorrhages in meninges covering dorsal surface of the spinal cord in the cervical region.

OUTBREAK NO. 14.

Mr. A. N. Hadley, of New Providence, lost 15 animals in cornstalk fields. He had lived on the farm for seven years, but this was the first appearance of the disease. Unfortunately word of this outbreak was not received until several days after the last death occurred. The history of the outbreak, as learned from Mr. Hadley, is as follows:

October 25, 38 cattle, mostly 2-year-old steers, were turned into a 20-acre cornstalk field and allowed to remain there continuously. October 30, 7 of the steers were found dead and at 2 p. m. 3 more had died. On the following morning (October 31) another steer was found dead. The remaining cattle were turned from this field into a cattle yard and fed hay together with a little corn on the ear. After

three or four days' stay in the yard they were turned into a second cornstalk field containing from 25 to 30 acres. At first they were kept in the field for from two to three hours daily, but after three days they were allowed to remain in the cornstalks during the day and were yarded at night.

November 15, the cattle were turned into a third field containing 20 acres, adjacent to the second one. As in the second field, they were allowed to remain in the cornstalks for only a few hours each day for the first few days. November 22, a steer was found dead in the morning and a second one died in the evening. The animals were known to have been sick for three or four hours. From November 23 to November 29, the remaining cattle were kept in a yard and fed as before. November 29, they were turned into field No. 4, which contained 35 acres, and were allowed to remain in this field continuously until December 7, without further loss.

December 2, 14 yearling steers were purchased and turned into the fourth field with the other cattle. December 7, all of the animals were turned back into field No. 3. There was from 6 to 8 inches of snow on the ground. December 9, two days after the cattle were turned into this field, two of the recently purchased yearlings were found lying on the ground unable to rise and died in a few hours. The death of these animals occurred in seven days after they were turned into field No. 4. After the death of these two animals the cattle were removed from the cornstalk fields.

The cornfields were on upland, excepting a narrow strip above a water course which passed through each field. In the first, third, and fourth fields the corn was good and the growth of stalks large, but in the second one the growth of the stalks was much smaller.

While in the first field the cattle had also the run of several acres of grass land from which a crop of hay had been removed. The first field was about a mile distant from the other three, which were adjacent to each other. There was only a small amount of smut in the first, second, and fourth fields, but in the third there was a much larger quantity. The cattle were salted irregularly while in the first field. Subsequently salt was constantly in the fields. While in the first field the cattle were supplied with water from a small stream which passed through it; in the other three fields they obtained water from a tank in an adjoining yard. Much of the corn from the first field had been "snapped" and was being fed to fattening cattle at the same time that the 35 animals were pasturing in the cornstalks. The "snapped" corn produced no ill effects.

A few symptoms were observed by Mr. Hadley. One of the animals (eighth to die) appeared to have a chill which lasted two hours before death. This animal, however, with several others, had broken into a neighbor's cornfield the day before, and the cause of death was evidently complicated with, if not due to, overengorgement with corn. This may explain the cause of the bloating.

OUTBREAK NO. 15.

This outbreak occurred on the farm of Mr. C. Keyser, of Percival. He had 80 acres of corn on "bottom" land, which had been under cultivation for many years and the stalk field was free from weeds. The corn was good. There was a moderate amount of smut.

November 26, 100 cattle, consisting of young cows (2 to 5 years old) and a few steers (2 to 3 years old), were turned into the cornstalk field and left there continuously. For a month prior to this they had been in another cornstalk field. December 2, 10 young cows were found dead. The remaining cattle were taken from the field, but after a day or two were returned. Twelve of these died during the next four days. The cattle were being watched when 3 or 4 of the cows were taken sick. They were reported either to move about strangely or stagger more or less for a few minutes, then fall down and die within an hour or two. December 4, 75 of the cattle were sold and shipped to Omaha.

Although the infected farm was visited as soon as possible after word of the appearance of the disease was received, the last animal to die had been dead for three days, and on account of advanced decomposition post-mortem examinations were not made.

OUTBREAK NO. 16.

This outbreak occurred on the farm of the French Community, near Corning. November 20, 75 cattle, consisting of 33 yearlings, 7 2-year-olds, and 35 cows, were turned into a cornstalk field for from ten to fourteen days. The yearlings remained in the field continuously, but the cows were yarded every night.

November 26, a 2-year-old heifer died. The other animals appeared to be well.

November 29, 7 yearlings were found dead. One yearling and a 2-year-old were sick. The yearling died in a few hours, but the 2-year-old recovered. None of the cows were affected.

About 60 acres of the corn were on upland and about 20 acres were on lowland. The cornfield on the upland and the one on the flats were separated by a considerable area of blue-grass pasture land, which was for the greater part on the flats. The corn was good. That on the lowland contained considerable smut, but there was very little on the upland. This was the fifth consecutive crop of corn on this land. The cattle had free access to a tank of water standing in the yard and supplied from a well by means of a windmill. The cattle were regularly salted every two or three days.

Mr. L. Brettanier, the herdsman for the community, observed the following symptoms in the first heifer to die: When first observed she was standing apart from the others "acting strangely;" her eyes had a wild or startled look, and at the same time she acted a little "crazy." In walking she would raise her hind feet with a peculiar jerky move-

ment. She soon began to stagger, and after a few minutes laid down and was unable to rise. She continued to move her head and limbs back and forth until death ensued.

OUTBREAK NO. 17.

This outbreak occurred on the farm of Mr. John Sunderland, of Hastings. He had 70 acres of corn, all on upland. The corn yielded a good crop and there was a heavy growth of stalks. It was the second year that corn had been cultivated on this land. There was considerable smut this year, but in 1892 there was very little.

December 3, 70 head of cattle (35 yearlings and 2-year-olds and 35 from 3 to 5 years old) and 10 horses were turned into the cornstalk field.

December 7, 7 of the young cattle were found dead. No deaths occurred subsequently. The horses remained well.

In 1892, 15 of a considerable number of animals pasturing in the cornstalks on this same land died. As in 1893, they were all young cattle, the older animals being apparently exempt from the disease.

OUTBREAK NO. 18.

This outbreak occurred on the farm of Mr. E. M. Carey, of Red Oak. He had 40 acres of corn on river-bottom land. There was a heavy growth of stalks and the corn was good. Previous to this year clover and timothy had been raised on this ground. When the field was examined (December 17) very little smut could be found.

December 7, Mr. Carey turned 226 cattle (about half of which were yearlings) into the 40-acre cornstalk field where they were allowed to run in the field continuously.

December 10, a 2-year-old heifer died very suddenly.

December 14, 16 yearlings and one 2-year-old were found dead. All of these animals were apparently well when they were seen on the preceding morning by the foreman of the farm. No deaths occurred subsequently, although the cattle were left in this field for several days. The dead yearlings were about equally divided between the two sexes, and one of the other cattle was affected. The cattle obtained water from the river, and were not salted. The cornfield was free from grass, and the animals had no food other than the corn fodder.

December 17, an examination was made of the dead animals. The post-mortem changes were too far advanced in most of the cases to enable the identification of slight pathological changes. In one case, however, the organs were quite well preserved.

NO. 12 (A YEARLING STEER).

This animal died on the morning of December 14, and was examined early in the morning of December 17. Post-mortem changes not as advanced as would naturally be expected. The liver was congested. The acini were distinct; the central portion was of a bright reddish color. The bile was normal in appearance and quantity.

The spleen was not enlarged; there were several ecchymoses beneath the capsule. The kidneys and urine appeared to be normal. The intestinal tract appeared to be normal excepting the omasum, which was unusually firm, although not impacted. The lungs were normal. There were several petechiæ beneath the epicardium, and post-mortem clots in both ventricles.

The brain was considerably softened, otherwise apparently normal. In one other case the liver, spleen, and heart exhibited lesions similar to those in No. 12. Intestinal tract normal.

Bacteriological examination.—Cover-glass preparations were made from the different organs and subsequently examined for bacteria. They gave negative results. Tubes of agar were inoculated with pieces of the liver, spleen, kidney, heart blood, and brain. December 21, the inoculated tubes were all clear. December 28, one of the agar tubes inoculated from the blood had developed into a pure culture of a spore-bearing bacillus belonging to the *Bacillus subtilis* group of bacteria. All of the other inoculated tubes remained clear.

About 3 c. c. of the blood were drawn up into a sterilized pipette and sealed. A rabbit inoculated subcutaneously with about 2 c. c. of this blood remained well. Four rabbits inoculated beneath the dura with from one to three drops of a suspension of the brain in bouillon remained well.

CORNSTALKS AFFECTED WITH "CORN BLIGHT," OR THE BURRILL DISEASE ARE FREE FROM PATHOGENIC PROPERTIES.

The large number of bacteriological examinations of the organs of cattle which died in cornstalk fields in the fall of 1892 showed conclusively that there was no single species of bacteria constantly present in the organs of these animals that could be cultivated under ordinary conditions. The evidence was convincing that if the bacillus of the corn disease did invade the organs of cattle it was either destroyed or rendered incapable of subsequent development on media satisfactory for the growth of the bacillus isolated by Professor Burrill. From Billings's report it is evident that the bacillus which he described is cultivated without difficulty. Billings, however, traced the origin of this disease in cattle to the affection of cornstalks described by Burrill¹ in 1889. The theory which he advanced was that the bacillus in the affected corn ingested by the cattle produced rapidly fatal results (septicæmia).

A review of Professor Burrill's description of the disease in the cornstalks shows that it attacks (1) the young corn in which the roots are first affected, and (2) the full-grown stalks after midsummer, when it manifests itself by certain discolored areas, more particularly on the leaf sheaths. In the young plant the disease, which is restricted to certain limited areas, dwarfs the stalks, resulting in the loss of the crop, while in the mature plant it is widely distributed and does not appear to be possessed of economic importance. The same species of a bacillus was isolated by Burrill from both the diseased root of the young corn and the lesions on the leaf sheath of the mature stalk. Billings²

¹ Those interested in the disease of corn are referred to Professor Burrill's paper on a New Bacterial Disease of Corn, Bulletin No. 6, University of Illinois, Agricultural Experiment Station, 1889; Proceedings of the Society for the Promotion of Agricultural Science, 1889, 19.

² Loc. cit.

also states that "this corn disease is exceedingly local in its extension, being not only limited to certain fields, but even to certain portions of such fields and most probably to certain stalks in a hill, or at least to individual groups of stalks." It appears, therefore, that Billings recognized but one form of the corn disease and his illustrations¹ show that to be the disease in the mature plant. It appears, therefore, that he mistook the disease in the full-grown corn, which is exceedingly common, for the more rare affection manifested in the dwarfed stalks, which he considered responsible for the death of the cattle.

This reported scarcity of the disease of corn said to be fatal to cattle, the failure to find a specific organism in the organs of the cattle examined in 1892, and the rapidity of the disease with symptoms said to resemble those of poisoning, led to the supposition that possibly animals which died while feeding in cornstalk fields might be poisoned from the bacterial products stored up in the diseased cornstalks. This led to an investigation of the cornstalk disease in its relation to the affection of cattle.

In August, 1893, I consulted Professor Burrill at Champaign, Ill., in reference to the corn disease which he had described. He very kindly offered me the use of his laboratory and personally pointed out the disease which he had described in the full-grown corn, and indicated the character of the lesions from which he predicted I would obtain pure cultures of the bacillus which he had found. It was too late in the season to study bacteriologically the dwarfed corn (result of the disease in the root of the young plant), and consequently my investigation of that form of the disease was limited to certain feeding experiments hereafter described. The examination of the disease in a large number of cornfields showed the lesions to correspond with the description of the disease in the mature plant as given by Professor Burrill, and consequently a further account of its appearance is not necessary.

A large number of agar and glycerin-agar cultures² were made from the lesions indicating the first stages of the disease in the leaf sheaths from cornstalks taken from fields at or near Champaign, and also from

¹The technique employed in making the cultures was very simple. The cornstalks were selected which showed from the exterior minute discolorations on the leaf sheaths. These were cut close to the ground and taken to the place where the cultures were made. The leaves and upper part of the stalks were then removed. The lower part was washed in a one-thousandth solution of corrosive sublimate. The closely fitting leaf sheaths were then removed by making first a deep circular incision just above the node, from which the diseased sheath was removed entirely or in part by means of gentle pressure with sterile forceps. With sterile (flamed) instruments a bit of the affected parenchymatous tissue was removed and placed in the culture media. It is of interest to add that a platinum loop rubbed over the inner surface of the freshly removed but tightly fitting leaf sheaths and then drawn over the inclined surface of agar in most cases showed these surfaces to be germ free. When the sheath was loose, however, its inner surface became contaminated with bacteria and fungi.

²Bulletins 22 and 23, Nebraska State Experiment Station.

similarly diseased corn from several other localities, more especially about Kankakee and Mazon. A few cultures were made from the dead roots of the dwarfed corn and from the erosions (old lesions) on the leaf sheaths, but these invariably developed, as predicted by Burrill, impure cultures often containing fungi which, on account of their rapid growth, caused the cultures to be abandoned.

A careful examination of a large number of cornfields situated at short intervals across the central and northern parts of the State of Illinois showed the disease in the mature corn to be exceedingly abundant. Later observations revealed its presence in the States of Indiana and Maryland, and it is highly probable that it is even more widely distributed.

The dwarfed corn was found to be quite rare. In addition to the statement that this was limited to certain circumscribed areas, it was learned that these areas always produced dwarfed cornstalks when the crop was repeated year after year. Mr. McClure, assistant horticulturist at the State University of Illinois, directed my attention to this disease on the farm of Mr. Hay, near Kankakee, Ill. I found in his cornfield a large number of areas, varying in size from a few square rods to an acre or more, upon which the corn was dwarfed and worthless. This was considered by both Mr. McClure and Professor Burrill to be a most typical example of the effect of the disease attacking the root of the young plant.¹

About 80 per cent of the cultures made from the first stages of the disease in the leaf sheaths contained a bacillus not distinguishable from the one described by Burrill. From the other cultures four species of saprophytic bacteria were obtained frequently in pure cultures. Although the bacillus described by Burrill was found in large numbers in the diseased cornstalks, its absence from the organs of the cattle dying in the cornstalk fields in 1892 rendered it desirable to test the pathogenesis of the affected cornstalks themselves. It was the intention to select thoroughly infected cornstalks and to feed them to cattle without an admixture of other food. The necessity for this artificial experiment, however, was eliminated by existing conditions brought about by more natural causes.

A drought which extended over the greater part of the State of Illinois in August and September, 1893, dried up the pastures and com-

¹I was first informed by Mr. McClure, and subsequently by others, that the germ theory of the dwarfing of the corn was losing ground and the previously entertained one, that it was due either to animal parasites or to a lack of "something" in the soil, was being revived. A careful study of this form of the disease is being made by both Mr. McClure, of Champaign, and Mr. Hay, of Kankakee. Mr. Hay is testing the efficiency of various fertilizers. He has found that a considerable portion of his land invariably yields dwarfed and worthless corn, while the land immediately adjoining it always produces a good crop. Thus far his experiments show that with a proper amount of fertilizers his land, which otherwise gave no corn, will yield a profitable crop. His experiments promise a practical method for preventing the loss now sustained from this cause.

pelled the farmers to feed their cattle. In many instances cornstalks were the only food given. As all of the corn was found to be affected with this disease, it was evident that no feeding experiment could be planned that would be more efficacious than those already being made. Several herds of cattle that were fed exclusively on these stalks were carefully watched for a period of several weeks, but no evidence of disease appeared. The cornstalks fed were carefully examined and found to be thoroughly infected with the Burrill disease. It should be noted that the cattle ate these stalks much closer than they did dried ones in the field later in the fall, and consequently they ingested many more of the diseased areas. It is of interest to add that so far as it was possible to learn, the cornstalk disease did not appear among cattle in 1893 in the districts visited in the fall and where the mature cornstalks were known to be badly affected by the Burrill disease. Unfortunately, no feeding experiment with the dwarfed corn was carried out with cattle. An experiment was planned for late in the fall with the dwarfed stalks from Mr. Hay's field, but a severe storm destroyed the stalks to such an extent that it was impossible to complete it. Enough of the blighted stalks were collected, however, for a rabbit experiment.

FEEDING DISEASED CORNSTALKS TO RABBITS.

Dr. Billings¹ fed the leaves of the diseased corn to a rabbit with fatal results. From the organs he obtained cultures of a bacillus identical with the one which he had isolated from the diseased organs of cattle dying of the cornstalk disease. In his writings concerning the distribution of the bacteria in the stalks and the difference in the pathogenesis of the organism isolated from different portions of the plant we find the following remarkable statement:

That it is in the stalks I myself have demonstrated by microscopic examination and cultures; but with this singular result: It is not disease producing when inoculated from this source in either rabbits or mice, while from the leaves it is, as we have seen from the feeding experiment in the black rabbit.

In the fall of 1892, a bundle of corn leaves and tassels was collected from an infected field (Outbreak No. 5) and sent to the laboratory at Washington for feeding rabbits.

Two rabbits were fed exclusively upon these leaves for a period of four weeks, during which time they remained apparently well. The animals had plenty of fresh water but no other food during this time. About three months after the feeding of the stalks one of the rabbits died. It was emaciated, but bacteria could not be found in cover-glass preparations from the organs, and culture media inoculated from them remained sterile.

In the fall of 1893, two feeding experiments were made with stalks known to be affected with the Burrill corn disease.

¹ Bulletin Nos. 7, 8, 9, and 10 (one volume), of the Agricultural Experiment Station of Nebraska, 1889, p. 134.

(1) Feeding of the leaf sheaths from the mature cornstalks.

(2) Feeding of the dwarfed stalks (disease in young corn).

In the early part of September several bushels of the badly diseased leaf sheaths were collected in the State of Illinois. Care was taken to select only those sheaths which were diseased and which presumably contained a very large number of bacteria. These were sent to the laboratory of the Bureau and used for feeding rabbits and for a chemical analysis. Likewise in the latter part of September a considerable quantity of the dwarfed yellow stalks, including leaves and roots, were received from Mr. Leon Hay, of Kankakee, Ill., whose cornfields contained many areas on which the corn was dwarfed and yellowish. Four rabbits were fed on each variety of the diseased cornstalks. The details of these experiments are given in the subjoined tables:

A.—Feeding rabbits with the diseased leaf sheaths.

Rabbit No.	Date feeding was begun.	Stopped feeding.	Remarks.
69	Sept. 6, 1893	Oct. 4, 1893	Emaciated; otherwise well.
70	do.....	do.....	Died Oct. 21. Emaciated; no other lesions observed; no bacteria discovered in the organs.
71	do.....	Oct. 4, 1893	Somewhat emaciated; otherwise well.
72	do.....	do.....	Do.

B.—Feeding rabbits with dwarfed cornstalks.

Rabbit No.	Date feeding was begun.	Stopped feeding.	Remarks.
73	Sept. 22, 1893	do.....	Died Oct. 17. Very poor; no lesions; cultures made from blood, spleen, liver and kidneys remain clear.
74	do.....	Nov. 1, 1893	Somewhat emaciated; otherwise well.
60	do.....	do.....	Do.
61	do.....	do.....	Do.

The rabbits were given plenty of water and all of the stalks (cut up) they would eat. They did well on the dwarfed cornstalks, but those fed only upon the leaf sheaths began to lose flesh after about two weeks, when they were given a small quantity of other food (wheat bran and oats) with the cut leaf sheaths.

The cause of death in rabbits Nos. 70 and 73 was not determined. It is highly probable, however, that it was due to malnutrition. The only abnormal condition that was discovered was marked emaciation. Tubes of agar and bouillon inoculated with bits of the organs and blood remained clear.

EXPERIMENTS TO ASCERTAIN THE EXTENT TO WHICH CORNSTALK FIELDS IN WHICH CATTLE HAVE DIED ARE DANGEROUS.

It was shown in the notes on the outbreaks of the disease in cattle that all of the animals that died in any particular cornstalk field did so in a very few days, and that the remaining animals were not appreciably affected. The cause of this peculiar condition can not be satisfactorily explained until the *etiological factor* is determined. A high degree of

susceptibility of the animals to the normal constituents of the cornstalks would presumably give rise to such a phenomenon. If the cause is a specific one, such as a microorganism, the clinical history would indicate that the destructive agent was either concentrated, so that the cattle which perished were the only ones that had become infected, or that it was more generally distributed and that a tolerance was established in those which survived presumably by reason of small initial doses. An important and interesting fact is that where the number of cattle was small and the acreage of corn large, all of the deaths occurred before the cattle had fed to any extent upon the cornstalks. In view of these facts a few experiments were planned by which it was hoped to demonstrate whether or not the destructive agent was eliminated from the fields with the first deaths. The plan suggested was to turn cattle which had been either on pasture land or in cornstalk fields in which no deaths had occurred into the infected field immediately after the deaths in the first herd had ceased. As it was the general opinion among the farmers consulted that after the first deaths no further loss would be sustained, some difficulty was experienced in obtaining suitable cornstalk fields for this purpose and also in securing satisfactory cattle. In the fall of 1892 only one such experiment was made, and it proved to be of little value, as the owner of the cattle insisted upon removing them from the field on account of the severe cold weather and a heavy fall of snow. In the fall of 1893 the following experiment was carried out by Dr. F. L. Kilborne:

In Outbreak No. 13 (page 33), which occurred on the farm of Mr. McCleary, of Van Meter, 5 animals from a herd numbering 35 died while feeding in a 20-acre cornstalk field within four days after they were turned into it. The cattle were in the field five days.

December 5, five days after the cattle were removed from the field, 20 2-year-old steers were turned into it. Ten of these were from a herd that had been in cornstalk fields, located about a mile distant, for about five weeks. The other 10 were from the herd first turned into the field and had been yarded since November 29. These were returned to further test their power of resistance.

At the time the experimental cattle were turned into the field there was about 8 inches of snow on the ground, which did not entirely disappear until the close of the experiment. There was no snow on the ground at the time the cattle in the first herd died, but other outbreaks have occurred in the presence of a greater or less quantity of snow, so that presumably this condition had no influence on the result.

During the experiment the cattle obtained water and salt the same as those which suffered from the disease.

Before the experiment was begun a wagonload of stalks on which smut had grown was cut for a more specific feeding experiment with that article. Only about one-fourth of the husks, leaves, or tassels usually eaten by the cattle had been consumed by the first herd.

The 20 steers remained in the cornfield continuously until December 16, a period of eleven days, without the appearance of the disease. They were then removed.

THE BACILLUS OF THE BURRILL DISEASE OF CORN.

The observations and experiments with the diseased cornstalks already recorded are enough to show the innocuous nature of its supposed specific organism. There are, however, several interesting facts in connection with this bacillus. As previously stated, a bacillus was obtained in pure cultures from about 80 per cent of the media inoculated with the beginning lesions in the cornstalk disease. In cover-glass preparations they usually appeared in considerable numbers, especially in those made from the gum-like substance frequently found in the inside of the leaf sheath beneath the lesions.

Although Professor Burrill very satisfactorily described the bacillus he found, according to the requirements of that time, the development of new methods for differentiating bacteria shows that a positive identification of bacteria recently isolated with those previously described is a matter of much difficulty, excepting where definite and characteristic pathogenic or physiological properties exist. In this case, however, I was fortunate in receiving from Dr. Smith a culture of a bacillus originally obtained from a culture of the bacillus of the cornstalk disease sent to him by Professor Burrill. A comparative study of the two cultures enabled me to identify the bacillus which I had isolated with the one previously received from Professor Burrill. It was found, however, that these bacteria differed from the original description in their growth upon gelatin. They both liquefied this medium. The liquefaction took place very slowly, however, which may explain the statement in Burrill's description that it does not occur, as he failed to state the age of the culture when last examined. As these bacteria in other respects correspond with the original description, this variation under the existing conditions does not appear sufficient for differential purposes. A study of these and the closely allied bacteria has shown that the power to liquefy gelatin and the quantity of gas produced by the fermentation of certain sugars varies somewhat as a result of continued artificial cultivation. The large amount of the disease in corn after midsummer led to a bacteriological examination of the soil from fields in Maryland, which resulted in finding very abundantly a bacillus closely related to the one obtained from the diseased cornstalks, and probably identical with it.

In 1893 Dr. Theobald Smith¹ identified the bacillus received from Professor Burrill and the one with which I compared my cultures as *Bacillus cloacæ*.² He also reports this organism from well water, both "polluted and unpolluted."

¹Wilder Quarter-Century Book, 1893, p. 214.

²This bacillus was isolated from sewage and was originally described by E. O. Jordan. Experimental investigations by the State board of health of Massachusetts upon the purification of sewage, etc. Part II, 1890, p. 836.

The cultures of this organism obtained from different sources were carefully studied in parallel cultures and found to differ very slightly. The greatest difference between them was in certain physiological manifestations. As this bacillus has already been described it seems necessary at this time to point out only the more essential differential properties of the bacillus obtained from the diseased cornstalks.

DESCRIPTION OF THE BACILLUS.

Morphology.—A motile bacillus varying in length from 1.3 to 2 μ , ends rounded. Appears in cultures singly or united in short chains or clumps. From five to fourteen flagella have been demonstrated. It stains readily with aniline dyes.

Cultural characters.—It develops a grayish, somewhat vigorous, glistening, non-viscid growth on the surface of agar. In the depth of agar it is more feeble. Gelatin is softened along the needle track and beneath the quite vigorous grayish growth which appears on the surface at the end of six days. It liquefies very slowly. The liquid gelatin is clear, with a viscid, grayish sediment. Strongly alkaline in reaction. On potato a dull grayish, nonviscid growth appears within twenty-four hours. In alkaline bouillon the multiplication is quite active, the liquid becoming heavily clouded in twenty-four hours. The casein of milk is coagulated in about eighteen days. It possesses active fermentation properties. In the fermentation tube filled with bouillon containing 2 per cent dextrose the closed bulb is filled with gas in forty-eight hours. The liquid is very acid in reaction. The gas consists of 72 per cent CO₂ and 28 per cent H₂. In a similar tube containing saccharin the fermentation is quite as active, but the proportion of the gas constituents is different, being 66 per cent CO₂ and 34 per cent H₂. In bouillon containing lactose the closed bulb of the tube is not filled with gas until the fourth day. The gas is practically the same as that produced in the saccharin bouillon.

The pathogenesis of the bacillus isolated from the lesions on the cornstalks was tested by a large number of inoculations with pure cultures into rabbits, guinea pigs, and mice. The animals were inoculated by different methods and with varying quantities of culture. One rabbit which received 0.75 c. c. of a bouillon culture in the ear vein died in fourteen days. It was very much emaciated, but no other evidence of disease was discovered. Bacteria were not found in the organs or blood. All of the other inoculated animals remained well.

The discovery of *Bacillus cloacæ* in the soil is of much significance. It harmonizes the results obtained by Professor Burrill in his bacteriological examination of the roots of the affected corn with the early conclusion that the cause of the dwarfing of the corn is not primarily the result of bacteria. It also explains how it is possible for the parenchymatous tissue of the leaf sheaths, husks, and leaves to be so generally sprinkled with lesions containing this organism. Whether these organisms are of themselves able to gain entrance into the parenchymatous tissue of the leaf sheaths after being lodged by various agencies against the exterior of the plant, or whether they are inoculated into the tissues by means of insects or injuries to the epidermis otherwise inflicted is not determined. The experiments of Professor Burrill would indicate the possibility of their power to penetrate the epidermis of the leaf sheath.

It appears that this organism, which is strongly saprophytic in many of its tendencies, is capable of multiplying in the tissues of the living corn plant, and consequently may be considered a facultative parasite.

A few cultures made from similar lesions contained a total of four other species of bacteria, which evidently had survived for a greater or less time in the parenchymatous tissue of the leaf sheaths, and, to all external appearances, had produced lesions not distinguishable from those associated with *Bacillus cloacæ*. This shows the existence of other usually saprophytic bacteria capable to a certain extent of such a parasitic life. The infrequency of their appearance, however, would indicate either their existence in the surroundings in much smaller numbers, or that, on account of their strongly saprophytic nature, they are unable to survive in the tissues of the living plant. Mr. H. L. Russell¹ has recently shown that a large number of bacteria, mostly saprophytes, are able to live for certain periods of time and to spread to a limited extent in living plant tissue.

CORN SMUT (*USTILAGO MAIDIS*) NOT FATAL TO ANIMALS.

Although the feeding experiments made by Professor Gamgee in 1868 and those at the Illinois State experiment station more recently, described on pages 11 and 15, gave negative results, it seemed desirable to make still further tests of the etiological power of this fungus. To this end the two following experiments were made by Dr. F. L. Kilborne:

(1) The load of cornstalks affected with smut (*Ustilago maidis*) removed from the field used in a preceding experiment (page 44) were fed to three 2-year-old steers, placed separately in box stalls in a barn on Mr. McCleary's farm. The animals had been in a cornstalk field for about five weeks prior to the feeding. They were fed exclusively on the smut-laden cornstalks and free smut mixed with a small quantity of a mixture of corn meal and wheat bran for seven days without ill effects. Owing to the absence of necessary appliances the weight of the animals and of the smut fed was not taken. It is safe to say that these animals consumed a much greater quantity of smut than the animals which died in the field. It was observed that the cattle did not eat the smut readily in the field, and in this experiment the animals refused it until apparently hunger compelled them to eat. The mixing of mill feed with the pure smut made it more appetizing, and consequently a much larger quantity was eaten than otherwise would have been done. The fact should be borne in mind that the smut used in this experiment came from a cornfield in which several animals had died within five days after they were turned into it.

(2) In December, 1893, six barrels of corn smut were collected from several cornfields in which cattle had not been turned, near Van Meter, Iowa, and shipped to the experiment stations of this Bureau. This material comprised both the abortive ears with the husks attacked by the smut and the masses of pure smut found growing on the stalks.

¹ Bacteria in their relation to vegetable tissue. Report of the Johns Hopkins Hospital, Vol. III (1893), p. 223.

The total weight was 280 pounds, of which at least one-half was smut.

Two heifers, Nos. 238 and 284, 15 to 18 months old, were placed in separate box stalls. They were bedded with peat moss instead of straw, in order that their food should consist exclusively of the prescribed ration. They were allowed to run in a small yard (16 by 30 feet) for about five hours daily.

During the experiment the animals were given all the well water they wished. They were not salted. The smut was apparently not relished by the heifers, especially by No. 238, so that it required considerable inducement to get them to eat the desired quantity.

Beginning on the morning of January 17, 1894, and continuing until noon of February 2 (sixteen and one-half days), the heifers were fed morning and evening with from 2 to 3 quarts of a mixture of equal parts by weight of cut hay and a mixture of corn meal, middlings, and wheat bran, and 16 quarts of smut. The actual quantity of the fungus consumed by No. 239 was 61 pounds, or a daily average of nearly $3\frac{7}{10}$ pounds, and by No. 284, $67\frac{1}{2}$ pounds, or a daily average of $4\frac{1}{2}$ pounds. The temperature of the animals was taken every morning and evening. The animals appeared to be perfectly well throughout the time of feeding, and continued so for several months during which time they were kept under close observation.

Table showing the temperature of animals during the feeding experiment.

Date.	No. 238.		No. 284.	
	8 a. m.	5 p. m.	8 a. m.	5 p. m.
1894.	Degrees F.	Degrees F.	Degrees F.	Degrees F.
January 16.		102		102.7
January 17.	101.2	101.4	101.5	102.4
January 18.	101.4	101.4	101.6	102
January 19.	101.2	101.8	101.5	101.4
January 20.	101.2	101.8	102	102.2
January 21.	101.4	101.6	101.8	102.6
January 22.	101.4	101.8	102	102.5
January 23.	100.8	101.8	101.8	102.4
January 24.	100.4	101.8	101.8	102.4
January 25.	100.7	101.7	102.2	102.4
January 26.	100.2	101.2	100.8	101.5
January 27.	101	101.2	100.7	100.8
January 28.	101	102.2	100.8	102
January 29.	100.7	102.2	101.6	102.2
January 30.	100.8	101.4	101.7	101.6
January 31.	100	102	101.6	102.6
February 1.	100.6	102	101.6	102
February 2.	100.4		100.8	

Several masses of the smut fed in this experiment were brought to the laboratory and examined microscopically to determine whether or not there were other fungi parasitic upon or associated with the *Ustilago maidis*, and which might possess destructive properties. These examinations failed to reveal the presence of any such organism. The negative results obtained in these experiments are additional evidence of the nonetiological importance of this fungus, at least so far as its power to produce disease in cattle is concerned. Careful search was made in the cornfields in which cattle had died for any diseased

condition of the corn, or for the presence of other plants or fungi which might be possessed of poisonous properties. Thus far no evidence of such a cause for the disease has been found.

ANIMALS OTHER THAN CATTLE NOT AFFECTED.

It has been of considerable interest to determine whether or not animals other than cattle are affected with this disease. Billings states that other herbivorous animals and horses are sometimes attacked. An agricultural paper, in estimating the total loss from this cause, includes a considerable number of horses. The replies to the circular letter (page 17), giving information on this disease, show that horses and sheep occasionally die while pasturing in cornstalk fields. It is a significant fact that the reports, by circular letter, of this disease in horses were for the greater part from people residing in the State of Kansas, and that Dr. Mayo¹ describes a disease² in horses (*Enzoötic cerebrites*, or "staggers") as occurring very extensively in the State of Kansas during the fall and winter of 1890 and 1891. He further states that there was very little cornstalk disease during this season.

In these investigations I found horses pasturing in cornstalk fields where cattle died in five of the eighteen outbreaks. Hogs fed upon the carcasses of the dead cattle in two outbreaks. Sheep were pastured in the cornstalk field in one instance. In this limited number of exposures the disease was not found in any of these animals. We have failed, therefore, to find any evidence of the existence of this disease in horses, sheep, or swine.

CHEMICAL ANALYSES.

Early in these investigations the necessity was felt for a knowledge of the chemical constituents and the physiological properties of cornstalks, especially those grown in the fields where cattle had died of this disease. Accordingly, small quantities of the following substances were collected and sent to Dr. E. A. de Schweinitz, chemist of the Bureau, for an analysis, especially with reference to the alkaloids or other substances which might be of a poisonous nature:

- (1) Cornstalks, mostly leaves and tassels, from the cornfield of Mr. C. Johnson. (Outbreak No. 5, 1892.)
- (2) The diseased leaf sheaths collected at Mazon, Ill., in August, 1893.

¹Bulletin No. 34, Experiment Station of the Kansas State Agricultural College, 1891.

²This disease is said to have been caused by a fungus, *Aspergillus glaucus*, on moldy corn which was ingested by the horses. The spores of this mold are stated to gain entrance to the circulation and find lodgment in the kidneys and liver, more frequently in the latter. The spores germinate and cause inflammation of these organs. The cerebral symptoms are the result of the formation of an abscess in the brain. This is caused by an interference with the blood supply, probably from spores or mycelia of the mold in the circulation. The spores of this fungus seem to retain their infectious properties for about six months. Mayo was unable to cultivate this fungus from the organs of the dead horses.

(3) The diseased cornstalks (dwarfed) from the farm of Mr. Leon Hay, of Kankakee, Ill., which were sent to the laboratory late in September, 1893.

(4) Liver of steer No. 11, which was sent to the laboratory in glycerin in December, 1893.

For the results of these analyses the reader is referred to the accompanying report of Dr. de Schweinitz. It appears, however, that they did not reveal the presence of any alkaloidal poison or inorganic salts in unusual or abnormal quantities. The necessity for a more extended chemical investigation is indicated in the discussion on the etiology of the disease on a subsequent page.

DISCUSSION ON THE NATURE OF THE DISEASE BASED UPON DATA OBTAINED IN THE SPECIAL INVESTIGATIONS.

The data recorded in the preceding chapter permits a more comprehensive view of this disease and of its economic importance than could heretofore have been taken. Although many important facts in the natural history of this malady are yet unknown, an analytical study of the results obtained will show that this disease of cattle is not such a plague to the Western farmers as it has been depicted.

CONDITIONS UNDER WHICH THE DISEASE OCCURRED.

The apparently contradictory statements made by farmers and cattle raisers concerning the conditions under which this disease occurs are clearly explained by the diverse management under which cattle dead from this malady were found in these investigations. A review of the essential facts determined in the different outbreaks summarized in the appended table will show that the fallacy of the popular theories is undoubtedly to be found in the fact that they are based on the conditions surrounding a very few outbreaks.

A synopsis of the general conditions found in the investigated outbreaks of cornstalk disease.

Outbreak.	Locality.	Date.	Total number of cattle.	Number that died.	Length of time cattle were in cornstalk fields daily.
1	Red Oak, Iowa.....	November, 1892.	70	2	First 6 days, 3 hours. Continuously.
2	do.....	do.....	56	1	First 3 days, 2 hours. Continuously.
3	Ames, Iowa.....	do.....	7	2	All day; yarded at night without food.
4	Red Oak, Iowa.....	do.....	24	4	First 3 days, 2 to 3 hours. Continuously.
5	Tyner, Iowa.....	do.....	22	7	Continuously.
6	Mechanicsville, Iowa.....	do.....	37	2	Do.
7	Toledo, Iowa.....	do.....	21	3	First few days, 5 hours. Continuously.
8	Stennett, Iowa.....	December, 1892..	25	5	First few days, 3 to 5 hours. Continuously.
9	Wales, Iowa.....	do.....	40	3	First few days, 3 to 5 hours. Yarded at night.
*10	do.....	November, 1892.	15	2	Continuously.
*11	Emerson, Iowa.....	do.....	140	10	Do.
12	Woodbine, Iowa.....	do.....	33	5	First few days, 3 to 5 hours. Continuously.
13	Van Meter, Iowa.....	October, 1893....	35	7	Continuously.
14	New Providence, Iowa.....	do.....	52	15	First 3 days, 2 to 3 hours. Continuously.
15	Percival, Iowa.....	November, 1893..	100	22	Continuously.
16	Corning, Iowa.....	do.....	75	9	Do.
17	Hastings, Iowa.....	December, 1893..	70	7	Do.
18	Red Oak, Iowa.....	do.....	226	18	Do.

A synopsis of the general conditions found in the investigated outbreaks of cornstalk disease—Continued.

Outbreak.	Food, other than cornstalks.	Size of corn fields.	Condition of corn.	Kind of land.	Water supply.
		Acres.			
1	Clover, meadow, and pasture.	20	Good	Upland	Spring (trough).
2	Clover meadow	About 40	do	do	Well.
3	None	13	do	Upland. One-fourth acre, low and wet.	Do.
4	Clover pasture	20	do	Upland	Do.
5	Millet and hay	12	Good on upland.	Small area of lowland in each field.	Stream.
6	Cut corn and tame hay.	3	Good	Upland	Well.
7	Pasture	20	Good on upland.	Nearly all upland	Do.
8	do	30	do	do	do
9	do	15	Good	Upland	Stream.
10	None	20	do	do	Well.
11	do	20	do	do	do
12	do	20	Fair	do	do
13	do	20	Good	do	Stream.
14	do	25	Fair to good	do	Spring.
15	do	20	First 2 fields good, otherwise fair.	Nearly all upland	Stream.
16	Pasture	80	Good	Bottom land, low	Do.
17	None	80	do	60 acres upland, 20 acres, lowland.	Well.
18	do	70	do	Upland	do
		40	do	Lowland	River.

Outbreak.	Salt given.	Time animals were known to be sick.	Quantity of smut (<i>Ustilago maidis</i>) on corn.
1	Frequently	4 to 12 hours	Less than usual.
2	Constantly in the field	Found dead	Very little.
3	Once in 5 days	1 found dead; 1 sick 2 hours	Do.
4	Once in 7 days	2 found dead; 2 sick 12 hours	Considerable.
5	Frequently	Some found dead; others sick a few hours.	Small amount.
6	do	4 to 5 hours	None (?)
7	Salt in trough constantly	3 to 12 hours	Considerable. All picked and drawn out of field when corn was harvested.
8	None	4 found dead; and 1 sick a few hours.	Moderate amount
9	Twice a week	A few hours	Small amount.
10	None	do	do
11	do	do	do
12	Frequently	Found dead, or sick a few hours	Considerable.
13	do	do	Small amount.
14	Irregularly at first, later in field continuously.	Found dead	Do.
15	do	do	Moderate quantity.
16	do	Usually found dead	Considerable.
17	do	Found dead	Do.
18	do	do	Very little, much less than usual.

* At the time outbreaks Nos. 10 and 11 were reached the cattle had been dead for several days and the owners were not present. The fragmentary knowledge concerning them was obtained from other members of the families.

From the table it will be observed that in eleven of the eighteen outbreaks the animals had plenty of salt, in three instances no salt was given, and in four outbreaks this fact was not determined. The animals in each of the outbreaks had free access to an abundant supply of water, or were provided daily with well or spring water.

The cornfields in which two of the outbreaks occurred were entirely on lowland. In nine outbreaks they were entirely on upland, and in seven they were on high and low land, but for the greater part on upland. The growth of the corn was vigorous in every field on the upland, and with few exceptions the crop was a good one on the lowland. The quantity of smut on the corn varied from very little to unusually large quantities. In one instance (Outbreak No. 7) all of the smut-bearing stalks were cut and drawn out of the field at the time the corn was harvested. In most instances the cattle were allowed to remain in the corn stalks for from one to three hours only each day for the first three to six days, while in the others they were left in them continuously. In a few instances the cattle had no other food than the cornstalks, but in the majority of cases they had access to stacks of hay or straw, or were allowed to run at will over pasture or meadow lands.

A careful inquiry into the common practice of farmers in certain sections of the country where this disease occurs disclosed the interesting fact that the conditions under which the cattle were usually kept, and the methods followed in wintering them, where no deaths occurred differed in no appreciable manner from those where many animals died. It was found that farmers as a rule furnish their cattle with plenty of salt and water, and that they usually take the precaution of allowing them to remain at first for only a few hours daily in the cornstalk fields. The practice of giving other food is frequently followed. In fact, so far as I have been able to determine, the methods followed by those who lose cattle and those who do not are identical. On this account obvious and peculiar conditions, which may be considered as favoring the appearance of the disease or forming a means for its prevention, have not been discovered. The method of caring for cattle by one man who loses heavily may be followed by a neighbor whose herd remains free from the disease, although the cornfields may be on apparently the same kind of soil and separated from each other only by a fence or at most by a public highway.

It was found that in certain outbreaks the cattle were pastured consecutively in two or more cornstalk fields. In these cases the deaths usually occurred in the last field, but in a few instances very soon after transferring the animals. The time which elapsed after the cattle were turned into the cornstalks before the first death occurred was variable, though usually from five to eight days. This is of much importance,

and in order to make a comparative study of this point with reference to the outbreaks investigated the appended table has been constructed:

Outbreaks.	Total number of deaths.	Number of cornstalk fields cattle were in.	Fields in which death occurred.	Number of deaths and days on which they occurred after the cattle were turned into the cornstalk fields in which they died.											
				1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1	2	1	First.....											1	1
2	1	1	First.....				1								
3	2	1	First.....					1	1						
4	4	1	First.....								1	1		1	
5	7	*2	First and second.....	12					4					1	
6	2	1	First.....									2			
7	3	2	Second.....								1	2			
8	5	2	Second.....					3	2						
9	3	2	Second.....							1	1		1		
10	2	1	First.....					1							1
11	5	1	First.....								2	3			
12	5	3	First and second.....		5	3				2					
13	7	2	Second.....		1	5	1								
14	15	4	First, second, and third.....					10	1	4					
15	22	1	First.....						10		12				
16	9	1	First.....						1		8				
17	7	1	First.....				7								
18	18	1	First.....			1				17					

* Where the cattle were in two or more fields the time occupied in each varied from one to two weeks.

† One steer died on the first day in each field. In the first instance death resulted presumably from the effect of dehorning.

‡ The cattle were kept out of the cornfield for three days (seventh, eighth, and ninth) after the death of the four animals.

§ All in the first field.

|| Eleven animals died in the first field. Two died in the second and two in the third field on the seventh day after being turned into them.

¶ The twelve animals died between the sixth and eleventh days.

The table shows that the great majority of deaths occurred from the fifth to the eighth day after the cattle were turned into the cornstalks. In the seven cases where the animals were in two or more fields deaths occurred in the first in three instances, and usually the time which elapsed after turning the animals into the second field, before they began to die, was as long as ordinarily occurred when they perished in the first field. This fact may be used as an argument to show that the causative agent was absent in the first, but present in the second field.

The previous history of the cattle was not obtained in all cases, but usually they had been turned into the cornstalks directly from pasture lands. As the cattle were not turned into the cornstalk fields until late in the fall it is evident that they had been feeding for several weeks upon grass more or less affected by repeated freezing.

The prevalence of the disease among young cattle was especially noticeable. Although the great majority of all the cattle in the herds in which deaths occurred were young, a few of the dairy herds consisted of young and old animals. In these the old ones invariably remained well. Those which suffered most were calves, yearlings, and 2-year-olds.

SYMPTOMATOLOGY.

As previously stated, opportunity was not afforded to observe an animal suffering from this affection prior to death. The insidious

nature and rapid course of the disease usually results in the death of the animal before its presence is detected. In a few instances, however, the sick animals were observed very carefully by their owners, from whom all the knowledge we have of the symptoms was obtained. Although little dependence can be placed on symptoms as ordinarily described by unprofessional and especially interested persons, a careful questioning rendered it possible to eliminate many of the customary exaggerations and to obtain a list of the more apparent manifestations of the disease.

Mr. Bixler (Outbreak No. 1) found a steer lying down and unable to rise. His head was extended, resting on the ground and moving continually from side to side; this was kept up for several hours, when he died. In the second case a steer was found to remain behind the other animals when they were driven to water about 11 a. m. At 3 p. m. he was found in a dying condition.

Mr. Williams (Outbreak No. 4) found his animals apparently well at 5 a. m. At 7 a. m. a heifer was found resting squarely upon her knees, the head extended and resting upon the ground. She was frothing at the mouth and groaning as if in great distress and died in about two hours.

Mr. Miller (Outbreak No. 5) found a calf lying down and unable to rise. The head rested on the ground and the eyes were rolled up. It kicked considerably and appeared to suffer intensely. It was shot in a few hours to relieve its sufferings. Another calf was found sick in the morning. It was placed in a barn, where for a few hours it was furious in its efforts to get out. Later in the day it laid down and could not be induced to rise. It was quiet part of the time, but usually kicked and bellowed as if in much distress and refused all food. There was a normal movement of the bowels in the afternoon.

Mr. C. Johnson observed a steer to act as if "crazy" at night. It was found dead the following morning.

Mr. J. G. Jones (Outbreak No. 9) observed several cases. The animals were very quiet. One of them exhibited a semi-comatose condition.

Mr. Hunt (Outbreak No. 12) described the symptoms to be similar to those observed in a dog poisoned with strychnine.

Mr. McCleary (Outbreak No. 13) stated that the sick animals were dull, exhibited great weakness, and walked with a peculiar jerky movement of the hind legs. The animals trembled as if suffering from a chill. In a short time they fell down and appeared to be in great distress, heads moving continually backward and forward.

Mr. Hadley (Outbreak No. 14) observed a sick animal trembling violently for about two hours preceding death.

Although the descriptions of the actions of the affected animals as given by the owners differ somewhat, there is a striking resemblance between them. It is unfortunate that a more thorough examination, especially in reference to the temperature, pulse, and respiration, was *not possible* in this investigation. These important symptoms will nec-

essarily remain undetermined until the opportunity of recording them is presented to properly trained persons.

It will be observed that the symptoms given by Gamgee do not differ materially from those here enumerated. Billings gives considerable space to the symptomatology of this disease, but for the greater part it is confined to the inoculation disease. On the evidence given we cannot at present accept the artificially produced disease as being identical with the cornstalk disease as it occurs in nature.

MORBID ANATOMY.

In all, twelve animals which died in cornstalk fields were examined. Post-mortem changes were more or less advanced in the greater number of these, although a few were examined soon after death. The post-mortems showed that while the macroscopic lesions were usually obscure and varied much in degree, they were constant and uniform in character. As would be expected, the structural changes in the various organs were very slight. This explains the statement of many veterinarians that the organs of cattle dying of cornstalk disease are normal in appearance. A summary of the lesions found in the twelve cattle examined, and their distribution in the body, is appended.

Nature and distribution of the lesions.

[Organs marked (a) were decomposed to such an extent that they were rejected.]

Animal No.	Outbreak.	Brain.	Lungs.	Heart.	Liver.	Spleen.	Kidneys.
1	1	Normal	No hep- tization.	Normal	(a)	(a)	(a)
2	1	do	do	do	(a)	(a)	Pale.
3	3	do	Normal	Hemorrhages beneath epi- cardium.	(a)	Enlarged; blood be- neath cap- sule.	Hemorrhages beneath cap- sule.
4	3	Hemorrhage beneath pia.	do	Hemorrhagic	Enlarged; oede- ma about peri- toneal attach- ment; hemor- rhagic areas.	Enlarged; hemor- rhagic.	Hemorrhages beneath cap- sule.
5	4	do	do	Normal	Center of lobules deeply red- dened.	Pulp soft.	Hyperemic.
6	5	Normal	do	(a)	(a)	(a)	(a)
7	8	do	do	Hemorrhages beneath serosa.	Center of lobules pale; periph- ery reddish.	Fibrous tufts on capsule.	Cortex pale.
8	8	do	do	do	do	do	Do.
9	10	do	do	do	Mottled; acini indistinct.	Dark	Cortex con- gested.
10	13	Normal	do	do	Acini distinct, centers red- dened.	Enlarged; ecchy- moses be- neath cap- sule.	Normal.
11	13	Punctiform hemorrhages in meninges.	do	do	do	Ecchymoses be- neath cap- sule.	Do.
12	18	Soft	do	do	do	Normal	Do.

* Post mortem changes well advanced.

† Brain not examined, as the animal was killed in the last stages of the disease by a blow on the head.

‡ Intestines were removed before our arrival.

Nature and distribution of lesions—Continued.

Animal No.	First and second stomach.	Third stomach.	Fourth stomach.	Duodenum.	Remaining intestines.	Lymphatics.
* 1	Normal.	Contents very firm.	Hyperæmic, few ecchymoses.	Hyperæmic, few ecchymoses.	Normal	Normal.
* 2	...do...	...do...	Hyperæmic...	...do...	...do...	Do.
3	...do...	Normal	Normal	Normal	...do...	Punctiform hemorrhages.
4	...do...	Contents unusually soft.	Hyperæmic...	Ecchymoses	Areas of congestion in ileum and cæcum.	Normal.
† 5	...do...	Normal	...do...	Areas of congestion.	Areas of congestion.	Do.
* 6	...do...	...do...	...do...	...do...	...do...	Do.
7	...do...	...do...	Areas of congestion.	...do...	Congested with hemorrhagic areas.	Edematous.
8	...do...	...do...	Deeply congested.	...do...	...do...	Do.
* 9	...do...	...do...	...do...	...do...	Lower ileum congested.	Normal.
10	...do...	...do...	Hyperæmic, with punctiform hemorrhages.	Normal	Normal	Do.
12	...do...	Contents firm.	Normal	...do...	...do...	

* Post-mortem changes well advanced.

† Brain not examined, as the animal was killed in the last stages of the disease by a blow on the head.

The table shows that the only gross pathological changes observed were those of a hemorrhagic nature. The hemorrhages were mostly confined to the serous membranes, and especially those of the heart. Ecchymoses were more or less numerous, however, beneath the pleura and over the surface of the liver and spleen. The mucosa of the intestinal tract showed areas in which the capillaries were deeply injected with occasional hemorrhage. In one case (No. 4) there were pronounced hemorrhagic areas in the heart muscle, aorta, and pleura.

The liver was frequently pale; the acini presented deep reddish centers with pale peripheries. Usually, however, post-mortem changes precluded the determination of the appearance of this viscus at the time of death.

The inner and middle zones of the lobules were more densely congested than the peripheral ones. A layer several lobules in thickness immediately beneath the capsule was usually more engorged with blood than the deeper portions of the organ. In the more densely injected areas not only the blood spaces were filled, but the liver cells were also separated from each other by a space of variable width containing blood corpuscles. In some cases there were slight changes in the appearance of the cellular protoplasm.

In all of the animals examined, in a suitable condition, the hemorrhages were of recent origin and the blood normal in its microscopic appearance. There were no discolored areas indicative of old ecchymoses. The distribution and general character of the hemorrhages,

which are the most conspicuous macroscopic lesions observed, are very similar to those described in certain cases of vegetable poisoning, more particularly that of fern root.¹

Although certain symptoms described by the owners were referable to the nervous system, lesions were not discovered in the brain or spinal cord excepting in one case (No. 4), in which there was considerable hemorrhage beneath the pia mater.

In one animal certain of the lymphatic glands exhibited more or less blood extravasation, particularly in the interlobular tissue.

Although somewhat limited in number, these examinations have shed much light upon two important lesions heretofore supposed to exist in this disease, viz, impaction² of the omasum (third stomach) and lung disease (pneumonia).

The third stomach (omasum) was found in one case (No. 1) to be firmer than normal. In all the others it was either normal or the contents were unusually soft.

In all of the animals examined the lungs were normal. It should be repeated that in addition to the twelve cases carefully considered, nearly as many other animals in which post-mortem changes were advanced were opened and the lungs found to be free from hepatization. The number of animals examined is enough to demonstrate the absence of pneumonia as a characteristic lesion in this disease. Furthermore, evidence to indicate a relation existing between this affection and the various forms of pneumonia to which cattle are susceptible was not discovered. This is important in view of the writings of Dr. Billings, who gives pneumonia as one of the most characteristic lesions in the disease.

Although the lesions are usually not conspicuous, the hemorrhagic changes described are readily detected upon careful examination. Unfortunately we have not the symptoms to compare with the lesions in those cases showing the less marked pathological changes. In the case in which the hemorrhages were most extensive (No. 4) the animal was reported to be sick but two hours and to have given evidence of intense suffering. The fact should not be overlooked that all of the animals from which this data was obtained had been in cornstalk fields from five to eleven days before death occurred. It will be seen from the table on page 53 that a few deaths occurred both before and after that time, but unfortunately an opportunity was not afforded of examining animals which died after such extreme exposures.

¹Journal of Comparative Pathology and Therapeutics, September, 1893; also editorial, June, 1894.

²The popular idea of "impaction" has presumably arisen from the fact that the contents of this viscus is normally much firmer than is ordinarily supposed.

(3) The diseased cornstalks (dwarfed) from the farm of Mr. Leon Hay, of Kankakee, Ill., which were sent to the laboratory late in September, 1893.

(4) Liver of steer No. 11, which was sent to the laboratory in glycerin in December, 1893.

For the results of these analyses the reader is referred to the accompanying report of Dr. de Schweinitz. It appears, however, that they did not reveal the presence of any alkaloidal poison or inorganic salts in unusual or abnormal quantities. The necessity for a more extended chemical investigation is indicated in the discussion on the etiology of the disease on a subsequent page.

DISCUSSION ON THE NATURE OF THE DISEASE BASED UPON DATA OBTAINED IN THE SPECIAL INVESTIGATIONS.

The data recorded in the preceding chapter permits a more comprehensive view of this disease and of its economic importance than could heretofore have been taken. Although many important facts in the natural history of this malady are yet unknown, an analytical study of the results obtained will show that this disease of cattle is not such a plague to the Western farmers as it has been depicted.

CONDITIONS UNDER WHICH THE DISEASE OCCURRED.

The apparently contradictory statements made by farmers and cattle raisers concerning the conditions under which this disease occurs are clearly explained by the diverse management under which cattle dead from this malady were found in these investigations. A review of the essential facts determined in the different outbreaks summarized in the appended table will show that the fallacy of the popular theories is undoubtedly to be found in the fact that they are based on the conditions surrounding a very few outbreaks.

A synopsis of the general conditions found in the investigated outbreaks of cornstalk disease.

Outbreak.	Locality.	Date.	Total number of cattle.	Number that died.	Length of time cattle were in cornstalk fields daily.
1	Red Oak, Iowa.....	November, 1892.	70	2	First 6 days, 3 hours. Continuously.
2	do.....	do.....	56	1	First 3 days, 2 hours. Continuously.
3	Ames, Iowa.....	do.....	7	2	All day; yarded at night without food.
4	Red Oak, Iowa.....	do.....	24	4	First 5 days, 2 to 3 hours. Continuously.
5	Tyner Iowa.....	do.....	22	7	Continuously.
6	Mechanicsville Iowa.....	do.....	37	2	Do.
7	Toledo Iowa.....	do.....	21	3	First few days, 5 hours. Continuously.
8	Stennett, Iowa.....	December, 1892..	25	5	First few days, 3 to 5 hours. Continuously.
9	Wales, Iowa.....	do.....	40	3	First few days, 3 to 5 hours. Yarded at night.
*10	do.....	November, 1892.	15	2	Continuously.
*11	Emerson, Iowa.....	do.....	140	10	Do.
12	Woodbine, Iowa.....	do.....	33	5	First few days, 3 to 5 hours. Continuously.
13	Van Meter, Iowa.....	October, 1893....	35	7	Continuously.
14	New Providence, Iowa.....	do.....	52	15	First 3 days, 2 to 3 hours. Continuously.
15	Percival, Iowa.....	November, 1893..	100	22	Continuously.
16	Corning, Iowa.....	do.....	75	9	Do.
17	Hastings, Iowa.....	December, 1893..	70	7	Do.
18	Red Oak, Iowa.....	do.....	226	18	Do.

A synopsis of the general conditions found in the investigated outbreaks of cornstalk disease—Continued.

Outbreak.	Food, other than cornstalks.	Size of cornfields.	Condition of corn.	Kind of land.	Water supply.
		<i>Acres.</i>			
1	Clover, meadow, and pasture.	20	Good	Upland	Spring (trough).
2	Clover meadow	About 40	do	do	Well.
3	None	13	do	Upland. One-fourth acre, low and wet.	Do.
4	Clover pasture	20	do	Upland	Do.
5	Millet and hay	12	Good on upland.	Small area of lowland in each field.	Stream.
6	Cut corn and tame hay.	60	Good	Upland	Well.
7	Pasture	3	Good on upland.	Nearly all upland	Do.
8	do	20	Good	Upland	Stream.
9	do	15	do	do	Well.
10	do	20	do	do	do
11	do	20	Fair	do	do
12	do	20	Good	do	Stream.
13	do	20	Fair to good	do	Spring.
14	do	25	First 2 fields good, otherwise fair.	Nearly all upland	Stream.
15	do	20	Good	Bottom land, low	Do.
16	Pasture	80	do	60 acres upland, 20 acres, lowland.	Well.
17	None	70	do	Upland	do
18	do	40	do	Lowland	River.

Outbreak.	Salt given.	Time animals were known to be sick.	Quantity of smut (<i>Ustilago maidis</i>) on corn.
1	Frequently	4 to 12 hours	Less than usual.
2	Constantly in the field	Found dead	Very little.
3	Once in 5 days	1 found dead; 1 sick 2 hours	Do.
4	Once in 7 days	2 found dead; 2 sick 12 hours	Considerable.
5	Frequently	Some found dead; others sick a few hours.	Small amount.
6	do	4 to 5 hours	None (?)
7	Salt in trough constantly	3 to 12 hours	Considerable. All picked and drawn out of field when corn was harvested.
8	None	4 found dead; and 1 sick a few hours.	Moderate amount
9	Twice a week	A few hours	Small amount.
10	None	do	do
11	do	do	do
12	Frequently	Found dead, or sick a few hours	Considerable.
13	do	do	Small amount.
14	Irregularly at first, later in field continuously.	Found dead	Do.
15	do	do	Moderate quantity.
16	do	Usually found dead	Considerable.
17	do	Found dead	Do.
18	do	do	Very little, much less than usual.

* At the time outbreaks Nos. 10 and 11 were reached the cattle had been dead for several days and the owners were not present. The fragmentary knowledge concerning them was obtained from other members of the families.

From the table it will be observed that in eleven of the eighteen outbreaks the animals had plenty of salt, in three instances no salt was given, and in four outbreaks this fact was not determined. The animals in each of the outbreaks had free access to an abundant supply of water, or were provided daily with well or spring water.

The cornfields in which two of the outbreaks occurred were entirely on lowland. In nine outbreaks they were entirely on upland, and in seven they were on high and low land, but for the greater part on upland. The growth of the corn was vigorous in every field on the upland, and with few exceptions the crop was a good one on the lowland. The quantity of smut on the corn varied from very little to unusually large quantities. In one instance (Outbreak No. 7) all of the smut-bearing stalks were cut and drawn out of the field at the time the corn was harvested. In most instances the cattle were allowed to remain in the corn stalks for from one to three hours only each day for the first three to six days, while in the others they were left in them continuously. In a few instances the cattle had no other food than the cornstalks, but in the majority of cases they had access to stacks of hay or straw, or were allowed to run at will over pasture or meadow lands.

A careful inquiry into the common practice of farmers in certain sections of the country where this disease occurs disclosed the interesting fact that the conditions under which the cattle were usually kept, and the methods followed in wintering them, where no deaths occurred differed in no appreciable manner from those where many animals died. It was found that farmers as a rule furnish their cattle with plenty of salt and water, and that they usually take the precaution of allowing them to remain at first for only a few hours daily in the cornstalk fields. The practice of giving other food is frequently followed. In fact, so far as I have been able to determine, the methods followed by those who lose cattle and those who do not are identical. On this account obvious and peculiar conditions, which may be considered as favoring the appearance of the disease or forming a means for its prevention, have not been discovered. The method of caring for cattle by one man who loses heavily may be followed by a neighbor whose herd remains free from the disease, although the cornfields may be on apparently the same kind of soil and separated from each other only by a fence or at most by a public highway.

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				1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1	2	1	First											1	1
2	1	1	First				1								
3	2	1	First					1	1						
4	4	1	First								1	1		1	
5	7	* 2	First and second	12					4					1	
6	2	1	First									2			
7	3	2	Second									1	2		
8	5	2	Second					3	2						
9	3	2	Second							1	1		1		
10	2	1	First					1							1
11	5	1	First								2	3			
12	5	3	First and second		§ 3					2					
13	7	2	Second		1	5	1								
14	15	4	First, second, and third					10	1	4					
15	22	1	First						10		¶ 12				
16	9	1	First						1			8			
17	7	1	First				7								
18	18	1	First			1				17					

* Where the cattle were in two or more fields the time occupied in each varied from one to two weeks.

† One steer died on the first day in each field. In the first instance death resulted presumably from the effect of dehorning.

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SYMPTOMATOLOGY.

As previously stated, opportunity was not afforded to observe an animal suffering from this affection prior to death. The insidious

Another fact that points to the probable toxic nature of this disease is the recovery of certain animals (see Outbreaks Nos. 13 and 16) which showed symptoms similar to those manifested by the animals which died. It was observed by the owners of these cattle that after the crisis was passed they recovered very rapidly. Although this disease is generally supposed to be invariably fatal, it is highly probable that a large number of animals are affected and recover.

The possibility of the existence of a fatal poison in the cornstalks is shown by the report of Dr. Mayo. It is not determined, however, that potash or sodium compounds are the only substances which might be produced in unnatural proportions under certain conditions in the corn plant. As the fatal quantity of known toxic substances appears to vary much in cattle, owing somewhat to the condition under which they are administered and largely to the degree of susceptibility of the individual animals, it seems to be necessary that further chemical analyses of cornstalks should be made. The stalks should be taken under different conditions, such as late in the fall, after their exposure to the fall rains and frosts, and when grown on different kinds of soil and the physiological and toxic properties of the substances thus obtained should be tested on cattle previously kept under different conditions. As the accumulated data point to the toxic nature of this disease, that hypothesis is provisionally assumed although the exact nature of the poison is not yet determined. It appears, however, to be restricted to the corn plant, and for that reason the disease it produces is designated *Toxæmia maidis*. The theory of the toxic effect on certain animals of the normal constituents of the cornstalks when taken in large quantities is strengthened by the fact that the disease does not occur in those sections of the country where the corn stalks are cut and properly cured, and where they are subsequently fed to cattle in small quantities, but sufficient in amount to keep the animals in good condition. It is hoped that chemical investigations of this disease may clear up the doubtful points.

ECONOMIC IMPORTANCE.

It is difficult to estimate the amount of loss caused by this disease. There are no statistics from which reliable data can be obtained concerning it, and, while it occurs to a certain extent every year, it is reported to be more frequent some seasons than others. It is usually confined to one or two herds in a single neighborhood, but its distribution is irregular, and frequently townships, counties, and even larger districts in the generally infected territory remain free from its ravages for years in succession.

Dr. Billings¹ summarizes the loss from this disease by stating that "it can be safely said that this malady causes more loss in cattle to the Western farmer than all other causes combined, not excepting abortion."

¹ Loc. cit.

Pyle¹ reports the loss in Nebraska for the season 1889 and 1890 to be about \$61,000.

The Farmers' Review for February 5, 1890, contains a summary of the reports of their correspondents concerning the prevalence of the cornstalk disease in the major portion of the corn-growing States.

The figures which are given are so divided between money value and the number of animals which perished that an accurate statement can not be made concerning either, but approximately² they are as follows: From Nebraska, a loss of \$59,094 among cattle and \$5,250 among horses. In Iowa, about 1,800 cattle and a few horses. In Missouri, about 350 cattle and a few horses; several counties are reported as sustaining a loss of from 1 to 7 per cent of their cattle. These statements show an enormous loss, but the text is not clear as to whether or not all of these animals died in the fall and winter of 1889 and 1890.

In the replies to the circular letter already mentioned, 634 men reported an ownership of 39,324 cattle, of which 3,229, or about 9.8 per cent, died in cornstalk fields in a single season.

In the twelve outbreaks investigated in 1892, 490 cattle were pastured in cornstalk fields in which the disease appeared and 46 of them died. In 1893, the percentage of loss was 14.5 per cent of the animals that were turned into cornstalk fields where the disease appeared, i. e., of the 558 animals exposed 81 died.

In estimating the percentage of loss from this disease there is great danger of an overestimate. In the township of Red Oak, Montgomery County, Iowa, there were 2,460 cattle in 1892, of which, so far as I could learn, only 6, or about one-seventh of 1 per cent of the total number, died in cornstalk fields. Further inquiry showed that in the entire county there were 29,169 (number recorded in county clerk's office) cattle, of which only 17 perished in cornstalk fields. Other years the loss was reported to be heavier, and still others less. These figures are given to show that the percentage of cattle which die in cornstalk fields is small when the thousands of herds in which the disease is not recognized, if it occurs at all, is considered.

The data obtained, therefore, show that this disease is not of such great economic importance as it has been thought. As it is noncontagious, it does not threaten the cattle industry of this or other countries to which American cattle may be shipped. In the herds where deaths occur the amount of loss is frequently heavy, but the infrequency of its appearance renders the average annual loss of cattle in any community from this disease exceedingly small. It is the universal testimony of the more experienced farmers that the amount of this disease is diminishing from year to year. Notwithstanding, it is a source of serious

¹ Journal of Comparative Medicine and Veterinary Archives, XIII, 1892.

²In the reports from counties some of the statements give the number of cattle, others the value of the cattle, and still others both the number of animals and their value. From the latter, the average value of an animal was estimated and from this result the approximate amount of loss was estimated.

loss and its prevention and elimination from the country is much to be desired. To accomplish this the method of prevention about to be indicated is urgently recommended.

PREVENTION OF THE DISEASE.

The rapid course of this disease indicates that prevention is the only practical remedy. As it appears in widely separated herds, there being many localities where it has never occurred, it is evident that the practical application of any general precautionary measure must be attended with very little expense, or the burden of prevention would be heavier than the loss of the occasional animals. As the disease is not contagious measures to prevent its spread are not called for, and the adoption of any method is for the sole purpose of protecting individual farmers against a possible loss of one or more animals from this disease. It has been shown that the methods now in vogue are not trustworthy, and the adoption of those heretofore suggested would, from the nature of the disease, be impracticable.

It has been observed in these investigations that a few farmers residing in the States where the disease is most prevalent, and who cut and feed their cornstalks after the method followed in the Eastern States, never lose cattle from this disease.¹ This is further illustrated by the history of the malady. Formerly it was the custom of the farmers in the States of Ohio and Indiana to turn their animals into the cornstalk fields after the ears had been picked from the standing stalks, and they reported losing many cattle from this disease. More recently the farmers in these States, with possibly few exceptions, cut their corn when it is ripe, and subsequently feed the properly cured stalks to their cattle. Frequently these stalks constitute the food for the cattle throughout the greater part of the winter. Where this practice is in vogue the cornstalk disease has disappeared. At the present time the practice of cutting the cornstalks is becoming prevalent in the State of Illinois, and several agriculturists of that State have stated that the losses from this disease are growing less and less each year. Although these illustrations may be considered coincidences, they conform to the long experience of the farmers of the Eastern and Middle States, who invariably cut their corn and feed the cured stalks and who never lose cattle from this malady.

In view of the history of this disease and the facts brought out in the investigations, the only method of prevention which commends itself to the consideration of the farmers who wish to protect their herds from this malady is to cut their corn when ripe, cure the stalks,

¹A most interesting illustration of this was found by Dr. E. C. Schroeder in the State of Missouri, in 1891. The conditions were as follows: Two farmers had large cornfields separated from each other by a wire fence. One of these men pastured his cornstalk field and lost heavily from the disease; the other cut his corn and fed the stalks with no ill effects whatever. The only difference in the conditions that could be found was in the method of feeding.

and subsequently feed them to their cattle. This method is based upon the experience of agriculturists as well as upon theory. The results of more scientifically arranged experiments could not be more demonstrative than those obtained by the actual experience of thousands of farmers.

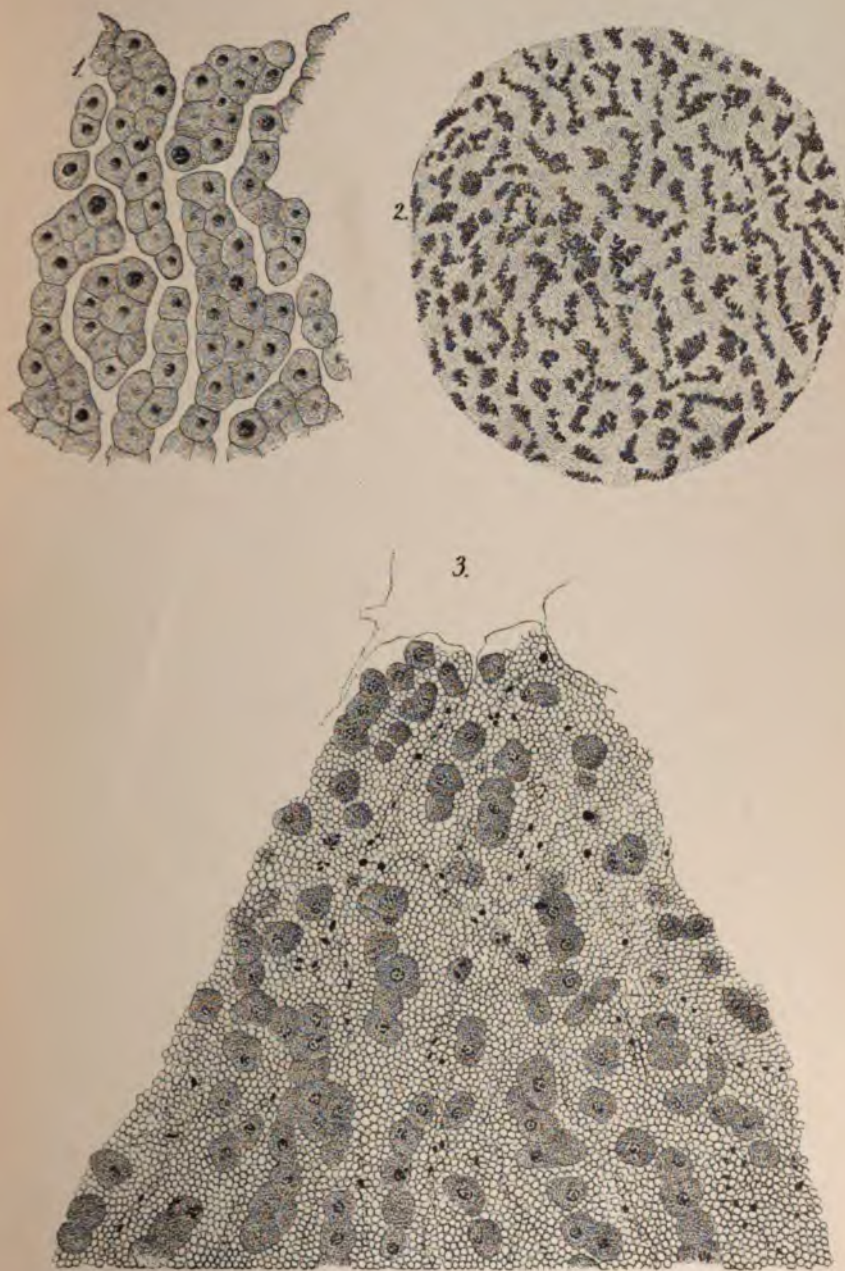
This method of prevention, if generally followed, will necessarily cause a radical change in the practice of farmers in the sections of country in which this disease occurs. At first thought it may seem impractical and unworthy of consideration, but a more careful study will show that it can be practiced with profit, especially on the smaller farms, where the amount of corn and the number of cattle are not large.

This method is urgently recommended, not only as a means of preventing an occasional loss of from 5 to 30 per cent of the cattle feeding in a cornstalk field, but also in its great economy of corn fodder.¹ The waste resulting from cattle running in cornstalk fields is notorious. The universal testimony of farmers who are feeding their cattle cut and properly cured cornstalks is that it pays. The quality of the stalks is much superior to that of the weather-beaten and bleached stalks left standing in the field. In addition to this, the amount of fodder obtained from a certain area is much increased over that utilized when the cattle run at will in the standing stalks, so that from a given acreage of corn a much larger number of animals can be wintered. While this means of prevention may not be practicable where large herds are driven from the Western plains to be wintered in the corn-growing sections where the acreage of cornstalks is extravagantly large, it is deemed practicable wherever economy in the use of forage becomes necessary. The slow but constantly increasing rapidity with which this method of feeding cornstalks is advancing from the East shows that it is a question of a few years before the custom will become universal throughout the West. When that time arrives the cornstalk disease of cattle will presumably not appear.

¹The importance of cornstalks as forage has been clearly set forth from a scientific standpoint by H. J. Patterson (Agricultural Science, Nos. 7, 8, and 9, Vol. VI, 1893), who has made a chemical analysis of the separate parts of the corn plant, such as the ear, husks, tops, leaves, stubble, etc. This analysis shows that the stalks contain a greater total of food constituents than the corn itself. He also shows that there is but little difference in the digestibility of different parts of fodder and that all its compounds, except the protein, are more digestible than those of timothy hay. He shows, furthermore, that the digestible matter in the fodder alone from an acre of good corn equals the digestible matter in 2 tons of either clover or timothy hay.

DESCRIPTION OF PLATE I.

- FIG. 1.—A drawing made from a section of a lobule of the liver of a healthy cow, showing liver cells and the blood spaces (magnified 500 diameters).
- FIG. 2.—A drawing from a section of liver from steer No. 4. This shows the liver cells and the engorgement of the blood spaces. Drawing traced with camera lucida, 8 mm. apochromatic objective; No. 4 eyepiece.
- FIG. 3.—A drawing from a section of the liver of steer No. 3, showing the separation of the liver cells and the intercellular spaces filled with blood (magnified 500 diameters).

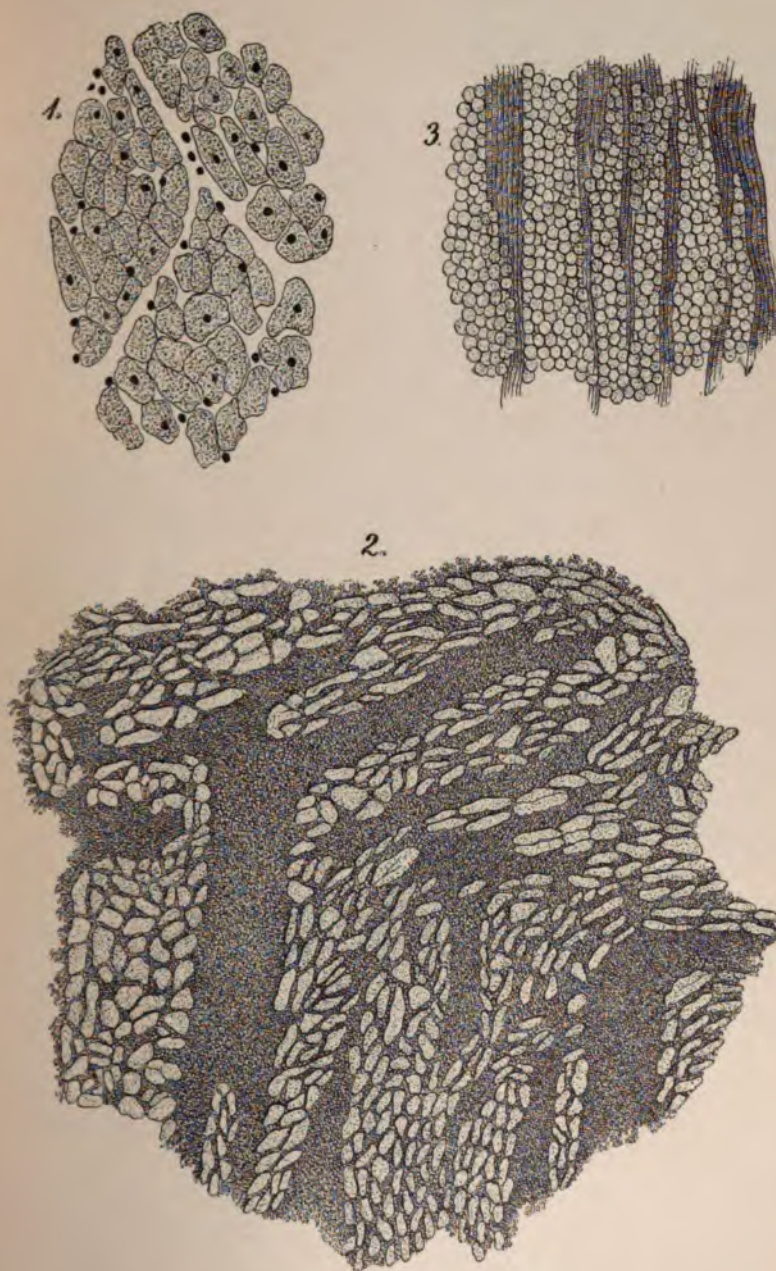


ENGORGEMENT OF BLOOD IN THE LIVER.



DESCRIPTION OF PLATE II.

- FIG. 1.**—A drawing from a section of normal heart muscle of a cow, showing cut ends of fibers (highly magnified).
- FIG. 2.**—A drawing from a section of heart muscle from steer No. 4. This shows the hemorrhage into the connective tissue surrounding the fibers and bundles of fibers. Traced with camera lucida, 8 mm. apochromatic objective; No. 4 eyepiece.
- FIG. 3.**—A drawing from the same section as fig. 2, showing longitudinal fibers and bundles of fibers surrounded with blood corpuscles. The muscle fibers themselves are not affected (magnified 500 diameters).



HEMORRHAGES IN THE HEART MUSCLE.

A DISEASE IN CATTLE NOT DISTINGUISHABLE FROM RABIES.

By VERANUS A. MOORE.

While investigating cattle diseases in the State of Iowa in the fall of 1892, Dr. Stalker, State veterinarian, called my attention to a peculiar affection which had appeared at variable intervals during the summer among the cattle belonging to Mr. John Wade, who resided near Greene, Butler County. The mystery surrounding this malady, as well as its economic significance, rendered an inquiry into its nature and cause exceedingly desirable. I therefore visited Mr. Wade on November 10, in response to a telegram announcing the reappearance of the disease. The following history of the affection was obtained:

Early in the spring of 1892, 47 2-year-old steers were turned into a pasture containing 100 acres, the greater part of which were on slough land. The field contained several acres, however, that were dry and covered with tame grass. In the slough portion water stood for a greater part of the summer between the bogs or tufts on the tops of which wild grass grew in abundance. The cattle were salted weekly, and water was pumped daily from a well at one side of the pasture into a large trough standing in the field. The well was bored through limestone rock and was said to be about 100 feet deep.

Late in June or early in July a steer was found dead. About a month later a second animal died. Early in September a third steer was taken sick and died in about three days. October 1, 2 steers died and later in the month 4 others perished. The last 4 animals were observed to be sick for about six days prior to death.

There were two other smaller pastures on high land, in which were 25 and 27 steers, respectively. In September, 100 cattle were purchased and turned into the pastures on the upland. Early in October the surviving cattle from the slough pasture were turned into the fields on the upland with the purchased animals. They were all fed subsequently on timothy and clover hay and snapped corn. The 4 steers which died late in October had, therefore, been on high land and fed as stated above for about three weeks prior to death. None of the cattle pastured during the summer in the fields on high land had died, and all the subsequent deaths were among the cattle which had been summered on the slough pasture. Mr. Wade had not lost cattle in previous years, and to his knowledge this disease had not before appeared in his vicinity.

Mr. Wade had already lost 9 animals, and subsequently 7 others died. Of the latter 4 were examined very soon after death. The symptoms observed in the sick animals, which were similar to those said to have been manifested by the previously affected ones, and the absence of apparent lesions sufficient to cause death, suggested the probability that they were dying of rabies. As indicated by this provisional hypothesis, rabbits and calves were inoculated with the brains of 3 (Nos. 1, 4, and 5) of the 4 animals for the purpose of obtaining data whereby a positive diagnosis could be made. The results demonstrated the fact that these animals were affected with rabies, or at least with a disease not distinguishable from that malady as determined by comparative inoculation experiments. A careful inquiry was made into the prevalence of rabies in the vicinity. It was learned that about 12 miles from this place several animals, all of which died of rabies, were bitten by a rabid dog about a year before. This was the only case of the disease found to have occurred, at least for several years, in this or adjoining counties.

As the source of infection is exceedingly difficult to explain, this outbreak is of much interest. The possibility of the presence of a rabid dog can not be gainsaid. Accepting it as a fact, it is quite an unusual condition to have animals bitten by a rabid dog early in the spring, die of rabies at variable intervals throughout the summer and early winter. The fact that no other animals in the neighborhood died, that mad or strange dogs were not observed during the entire summer, and that a careful inspection of the skin of the animals examined failed to reveal the presence of scars suggestive of bites or other injuries, all tend to preclude the probability that the cattle were infected at different times by means of the bites of different dogs. The importance of this disease warrants a somewhat detailed description of each of the animals examined, and an account of the inoculation experiments resulting in the diagnosis made.

SYMPTOMS AND LESIONS IN THE CATTLE EXAMINED.

STEER No. 1.

A 2-year-old steer was found in an almost dying condition November 10. He had been sick for five days. When first attacked he was said to have been in good condition, but he was now much emaciated. Mr. Wade stated that the most marked symptoms which he observed in this animal were indifference to food and water, and persistency in driving hogs, dogs, hens, and other small animals from the yard. He would not attack persons. Occasionally he bellowed as if in great distress. The hind limbs were drawn under the body more and more each day, so that by the third day walking became difficult. At times he would run about the yard in an apparent frenzy. When observed (November 10) he walked with great difficulty. The hind legs were drawn under the body and there was marked loss of coordination. In stepping with the hind legs the weight rested first on the toes. After a few steps he would fall on the ventral surface of the body, bringing the four legs beneath him. He could rise only with difficulty. The eyes had a dull appear-

ance and were deeply reddened. Judging from the previous case, Mr. Wade thought that he would live but a few hours. He was killed (by cutting the carotids) for examination.

Autopsy—Steer much emaciated. Mouth and œsophagus normal. Rumen contained a considerable quantity of moist, partly macerated food, consisting of straw, hay, corn, and corn husks. The third and fourth stomachs were normal. The mucosa of the duodenum and jejunum was covered with a layer of bile-stained mucus, otherwise the intestinal tract was normal. Lungs normal. There were a few subserous blood extravasations on the left ventricle. The liver was apparently slightly enlarged, normal in color. There were about 400 c. c. of a thin, clear, greenish-yellow bile.

The spleen was abnormally dark in color. The normal markings were present.

The medullary portion of the kidneys was slightly reddened. Cortex pale. Capsule easily removed. Bladder empty. The lymphatics normal.

The frontal lobes of the brain presented a surface thickly sprinkled with pigment. The blood vessels were slightly injected, especially in the choroid plexus. Spinal cord normal in appearance.

The microscopic examination, on the following day, of the various tissues did not reveal abnormal changes, and stained cover-glass preparations from the various organs and blood did not show the presence of bacteria or other microorganisms.

Bacteriological examination.—At the autopsy tubes of agar were inoculated with pieces of the brain, liver, kidney, spleen, and the heart blood. Liquid agar was also inoculated with parts of the brain (Liborius' method of making cultures). All of the culture media inoculated with the spleen, liver, kidneys, and blood remained clear. One of the agar cultures of the brain contained *Bacillus fluorescens liquefaciens* in pure culture.

November 12 an emulsion was made by grinding up a small piece of the brain tissue taken from beneath the pia of the right frontal lobe with a few cubic centimeters of sterilized water. The brain had been kept in a cool place since its removal (November 10), and when used post-mortem changes were not detected.¹ Two rabbits were etherized and inoculated with one to two drops of the emulsion, one beneath the dura and the other in the anterior chamber of the right eye. The rabbit inoculated in the eye remained well, but the other developed the following symptoms:

November 25, thirteen days after inoculation, the attendant² stated that the rabbit acted very queerly. November 26 he showed partial paralysis of both hind limbs and could not stand. Hyperæsthesia of the right hind leg, but the left one was apparently devoid of sensation. The rabbit tried from time to time to get up, but invariably failed. It refused food and water. There was no ferocity manifested; temperature normal. It was found dead on the following morning, fifteen days after the inoculation. The post-mortem showed injection of blood vessels of the heart. The liver was slightly reddened. Several cysticerci in abdominal cavity. Intestinal track normal. At point of inoculation the brain had a pale greenish color over an area 2 to 3 mm. in diameter. Blood vessels of the meninges slightly injected. No other evidence of disease.

Stained cover-glass preparations made from the blood and organs exhibited no bacteria. Tubes of culture media inoculated from the same remained clear.

November 28 a second rabbit was inoculated beneath the dura with a drop of the emulsion prepared from the brain of the dead rabbit. It died December 2. The examination showed an extensive inflammatory condition of the meninges of the brain about the point of inoculation.

¹The delay was necessitated by the distance of the outbreak from Ames and the procuring of the rabbits.

²The fact that much of the time I was necessarily in the field prevented the taking of full notes on the symptoms of the animals inoculated at Ames.

STEER No. 2.

This steer was first observed to be sick on the evening of November 10. It showed symptoms similar to those manifested by No. 1 and died November 13. It was examined November 14 in company with Dr. Niles. The post-mortem changes were considerably advanced. The intestinal tract appeared to be normal, with the exception of a thick layer of mucus over the mucosa of the duodenum. The liver, spleen, and kidneys were discolored from decomposition. A considerable quantity of clear, straw-colored serum beneath the dura. The blood vessels of the pia and choroid plexus injected. No hemorrhage. Over the frontal lobes the pia presented a stippled appearance due to fine and coarser pigment. The pigmentation was most intense about the olfactory bulbs. The microscopic examination of the pigment showed it to be composed of roundish or rectangular granules of a dark brownish color, varying from 0.5 to 1.5 μ in diameter.

Several tubes of agar were inoculated from the brain substance at the time of the autopsy. Part of these remained clear; the others developed into impure cultures of saprophytic bacteria.

As the steer had been dead for some time prior to examination rabbits were not inoculated beneath the dura with its brain. A single rabbit, however, was inoculated subcutaneously with a piece of the brain substance and remained well.

STEER No. 3.

A 2-year-old steer was taken sick about November 10, and died during the night of November 12. He was said to have exhibited symptoms similar to those already described. He was examined November 14, but the post-mortem changes were too far advanced to determine any slight abnormal changes at the time of death.

STEER No. 4.

A 3-year-old steer was taken sick November 19. The first symptom noticed was his persistent chasing of all the smaller animals which came near him. This was followed by paroxysms, in which he would run against fences and farm buildings. He was placed in stanchions to prevent him from injuring himself or other animals. He was at all times uneasy, would bite up a mouthful of hay or dirt and act as if in great distress. He ate and drank very little, and swallowed with apparent difficulty. He exhibited the same paralytic symptoms as described for No. 1. The feces were observed by Mr. Wade to be much darker in color than usual. He died on the morning of November 24.

Autopsy.—The examination was made within a few hours after death, the body being still warm. The animal was reported to have lost considerable in weight during the attack. The estimated weight at time of autopsy was 1,100 pounds. The lower jawbone on right side was fractured and the surrounding tissues oedematous. The mucosa of pharynx, larynx, and upper 3 inches of the trachea were sprinkled with punctiform hemorrhages which were also found in small numbers in the lower part of the trachea and larger bronchi. Considerable straw-colored oedema beneath tongue, just posterior to frænum. The lymphatic glands of the throat were deeply reddened and oedematous. Beneath the pleura on the costal surface of the thoracic cavities were numerous blood extravasations, 3 to 10 mm. in diameter. Lungs not collapsed; hyperemic, but no hepatization in lung tissue. Ecchymoses on base of aorta and over heart. Dark post-mortem clots in both ventricles. Punctiform hemorrhages beneath endocardium over pyramids and around apex of left ventricle. Abdominal organs normal.

The brain presented no abnormal appearance, excepting a slight injection of the blood vessels. The spinal cord appeared to be normal throughout. The brain was carefully covered and placed in glycerin and sent by express to the laboratory at Washington, where rabbit inoculations were made by Dr. Smith. (See page 77.)

Bacteriological examination.—A large number of tubes of culture media were inoculated with different tissues and organs of this animal. The majority of these remained clear. A streptococcus developed in pure culture in media inoculated with the blood. It was extremely delicate in its cultural character, but mice inoculated with a pure culture remained well. This streptococcus perished before its study was completed. A spore-bearing bacillus resembling *Bacillus subtilis* was obtained from the spleen and a nonpathogenic motile bacillus was isolated from the liver.

The microscopic examination of the tissues, both in the fresh condition and in sections of the organs preserved in alcohol and Müller's fluid, failed to reveal any abnormal conditions.

STEER No. 5.

A steer 3 years old. This animal was first observed to be affected November 21. From that time to November 24 he exhibited symptoms similar to those manifested by No. 4, excepting that the paroxysms were less marked. November 24 this animal came under my observation. He was lying down most of the time. He got up frequently and would walk a short distance and fall. In walking there was considerable trembling of the body. His movements were uncertain, the hind feet were placed well under the body and there was "knuckling" in all four feet, with an apparent loss of coordination. Temperature, 102.3° F.; pulse 42, weak; respiration, 24, not labored; temperature, 101.8° F. Smaller animals, especially dogs, were driven from the yard so long as he could walk, but no signs of ferocity observed. He would come up to a person, but when a hand was placed on his head or nose he would stop and act perfectly docile. Toward night he was unable to stand for more than a few minutes at a time. Eyes were dull and the blood vessels of the conjunctiva considerably injected. November 25 the steer was unable to rise. Conjunctiva deeply congested. Temperature, 91.6° F.; pulse very weak; respiration almost imperceptible. At 11 a. m. he was killed by bleeding.

Autopsy.—Blood appeared normal and clotted readily. No oedema or ecchymoses about mouth, pharynx, or larynx, as in No. 4. Ecchymosis in cephalic and ventral portion of lungs. Lungs not congested, but partially collapsed. A few punctiform hemorrhages beneath the endocardium of the pyramids of the left ventricle; otherwise heart normal. Lymphatics normal. Spleen much enlarged, dark colored, and friable. Upon section the capsule reverts with slight bulging of the pulp. Liver enlarged, edges rounded; in section it presented a dull, pale red color, mottled with grayish areas 1 to 3 mm. in diameter; about 700 c. c. of viscid, very dark colored bile holding solids in suspension, otherwise clear.

Kidneys normal in appearance. There were about 250 c. c. of clear acid urine in the bladder. Examination showed the absence of albumen. No lesions could be found in the intestinal tract. Contents normal.

The blood vessels of the meninges covering the brain were slightly injected. An unusually large amount of pigment on frontal lobes. Blood vessels of choroid plexus much injected. No liquid in ventricles. The gray and white matter normal in appearance.

A microscopic examination of the blood and tissues in a fresh condition showed the epithelium of the kidneys to be slightly granular. Sections of these organs from pieces hardened in alcohol and Müller's fluid showed no appreciable change in the cellular structure. The blood spaces in the liver contained a considerable number of red corpuscles.

Bacteriological examination.—At the autopsy tubes of agar and glycerin agar were inoculated with pieces of the brain, liver, spleen, kidneys, and with several loops of heart blood. The tubes inoculated with the brain, liver, and spleen remained clear. Those inoculated from the blood developed into impure cultures of saprophytic bacteria. A chromogene was obtained from the kidney. About 30 c. c. of the heart blood were transferred by means of a flamed pipette from the heart to a sterile tube. This

was placed in an incubator in about eighteen hours. The serum which oozed out of the clot remained clear. Cover-glass preparations from the different organs showed, when properly stained, no bacteria or other organisms.

Anaerobic cultures were made after Liborius' method from the kidney, liver, spleen, and brain. All of these remained clear.

November 28 a heifer calf (No. 19) about 2 months old was inoculated beneath the dura with a few drops of a suspension of the brain of steer No. 5. The calf was chloroformed, trephined on the left side of median line, and the emulsion injected beneath the dura by means of a syringe. A small quantity of blood and presumably a portion of the injected liquid escaped after withdrawing the needle. The wound healed nicely. The temperature remained normal for three days, after which it was not taken for a period of twelve days.¹ December 15, seventeen days after the inoculation, the temperature was 100.3° F. The calf appeared to be weak, laid down often, rose without much difficulty, and bellowed frequently. There was considerable dribbling of saliva. December 16, temperature 98° F. December 17, temperature 98.4° F. Calf was very weak, loss of coordination in walking, fell frequently, and rose only after several efforts. Some bloating. Reported by the man in charge to refuse food almost entirely. Dribbling of saliva less marked. December 18, temperature 89° F. Paralyzed. December 19, calf found dead.

Autopsy.—Calf considerably emaciated. Mucosa of mouth and pharynx normal. Lungs normal. Both ventricles contained dark, firm clots. Liver normal in appearance. About 100 c. c. of dark bile holding finely divided particles in suspension. Slight edema in pelvis of kidneys. Urine dark, cloudy, and acid in reaction. Intestinal mucosa generally covered with mucus, a few punctiform hemorrhages in caecum. Contents of colon firm and covered with mucus. Lymphatic glands slightly edematous. The brain and its membranes appeared to be normal. Slight amount of pigmentation. Tubes of agar were inoculated with pieces of the spleen, liver, kidney, and brain. One of the tubes inoculated with the brain contained a few colonies of *Bacillus coli communis*; the others remained clear.

November 26 a heifer calf about 9 months old was inoculated intravenously with 14 c. c. of defibrinated blood from steer No. 5. The calf remained well.

STEER No. 6.

This animal was taken sick December 8, and died December 12. The symptoms were reported to be the same as those exhibited by previous animals. No post-mortem examination was made.

STEER No. 7.

A steer 18 months old died during the night of December 13. This animal was found sick December 11, and it was not known how long he had been sick. The symptoms were reported to be the same as those in previous cases. The partial paralysis and "knuckling" were especially well marked. Examination made December 14, at 10 a. m., by Dr. Kilborne.

Autopsy.—General condition good; weight about 500 pounds. Mouth, throat, and lungs were normal in appearance. Heart muscle flabby; the left ventricle nearly filled with a firm post-mortem clot. The right ventricle contained a dark clot and liquid blood. A few punctiform hemorrhages were beneath the endocardium of the left ventricle.

The liver was attached to the diaphragm by firm fibrous adhesions of long standing. The surface was marked by several scars, otherwise the liver appeared to be normal. The gall bladder contained about 500 c. c. of dark greenish viscid bile, holding solids in suspension. The spleen was enlarged to twice its normal size. Pulp of a dark blackish color, and rather soft. Malpighian bodies visible in fresh

¹I am indebted to Dr. Kilborne for the notes on the symptoms and post-mortem condition.

sections. The enlargement appeared to be due to an increase in the number of red corpuscles. The cortex and base of pyramids of the kidneys pale. Capsules easily removed. The bladder contained about 1,500 c. c. of clear urine. No albumen. The addition of nitric acid produced an unusual amount of effervescence.

The contents of the third stomach somewhat dry. In the fourth stomach a slight edema of the laminae with several erosions of the mucosa. The latter in the duodenum appeared swollen and covered with an abnormal amount of mucus. A slight injection of the blood vessels. In the ileum the mucosa was covered with a thin layer of cells. Cæcum and colon normal. Lymphatic glands normal in size. The membranes covering the brain presented an arborescent appearance from the injection of the blood vessels. A slight hemorrhage on the left hemisphere near the longitudinal fissure. Considerable pigment over the frontal lobes. No fluid in the left lateral ventricle. A small quantity of blood-stained serum in the right lateral ventricle. Choroid plexus deeply injected.

A microscopic examination showed the blood and organs to be apparently normal. Tubes of culture media were inoculated with pieces of the liver, spleen, and kidney. Those inoculated from the spleen and kidney remained clear. One of the agar tubes inoculated with the liver developed into a culture of a motile bacillus. Unfortunately this culture was inadvertently rejected.

COMPARATIVE INOCULATIONS.

The positive diagnosis of rabies was not made until the results of a series of inoculations with the virus obtained from steer No. 4 were obtained and carefully compared with those of a parallel series with virus obtained from a rabid dog. As previously stated, the brain of steer No. 4 was carefully removed, placed in pure glycerin, and shipped by express to the laboratory at Washington, D. C., where it was received four days later. It was kept in a refrigerator for five days, when Dr. Theobald Smith made, from a portion of the medulla, a suspension in peptonized beef broth and injected about 0.24 c. c. beneath the dura of rabbit No. 398. This rabbit died in about seven weeks with symptoms of paralytic rabies. Two rabbits inoculated with an emulsion prepared from a piece of the brain of rabbit No. 398 subsequently died with similar symptoms. The series of inoculations thus begun extended over a period of nearly seven months, in which eleven rabbits were used, all of which died with symptoms of paralytic rabies.

Although comparative inoculations were made in several rabbits and calves which were carefully watched during the disease and examined post-mortem with the greatest care, there was not present any constant condition or conditions which enabled one to detect a difference between the diseases produced by the virus from different sources. The essential data obtained in these inoculations are here given.

INOCULATIONS WITH THE VIRUS ORIGINALLY OBTAINED FROM STEER NO. 4.

Rabbits and calves were inoculated with this virus beneath the dura, intravenously, and into the subcutaneous tissue. The data important from the diagnostic standpoint was obtained from the intracranial inoculations. The other methods were usually ineffective, although a few fatal results were obtained by the subcutaneous process. Atten-

tion is called particularly to the symptoms manifested by the different rabbits and the uniformity in the time between inoculation and death. The long period of incubation in the first rabbit inoculated was presumably due to the length of time the brain remained in the glycerin prior to its use. The number of rabbits used for subdural inoculation, the date of inoculation and death, are given in tabulated form. The symptoms and post-mortem notes for each animal follow the table.

A.—Subdural inoculations in rabbits.

Rabbit No.—	Virus used.	Date of inoculation.	Date of death	Period of time rabbits lived after inoculation.
				<i>Days.</i>
398	Brain of steer No. 4.....	Dec. 3, 1892	Jan. 18, 1893	46
420	Brain of rabbit No. 398.....	Jan. 18, 1893	Feb. 6, 1893	19
418	do.....	do.....	do.....	19
424	Brain of rabbit No. 420.....	Feb. 9, 1893	Mar. 5, 1893	24
433	Brain of rabbit No. 424.....	Mar. 9, 1893	Mar. 31, 1893	22
434	do.....	do.....	Mar. 30, 1893	21
458	Brain of rabbit No. 434.....	Mar. 31, 1893	Apr. 19, 1893	20
496	Brain of rabbit No. 458.....	Apr. 21, 1893	May 9, 1893	18
9	Brain of rabbit No. 496.....	May 10, 1893	May 29, 1893	19
449	Brain of rabbit No. 9.....	June 3, 1893	June 24, 1893	21
56	Brain of rabbit No. 449.....	June 26, 1893	July 18, 1893	22

RABBIT No. 398.

This rabbit remained well until January 16, forty-three days after its inoculation, when it became partially paralyzed in the hind limbs. There were no other signs of brain derangement. The rabbit ate sparingly of green cabbage.

January 17: The rabbit was found lying on one side feebly moving the forelegs, gasping as if dying. This condition continued all day.

January 18: Rabbit found dead. Subcutaneous veins filled with tarry blood; marked venous injection of the intestines. Cortex of the kidney and the base of pyramids pale, the remaining portion of a deep reddish color. Liver pale; spleen barely enlarged. Lungs pale. Heart contained tarry blood. The brain surface was marked with injected blood vessels.

RABBIT No. 420.

Paralysis observed February 2, fifteen days after inoculation. It was unable to move its hind limbs, but dragged itself along with the forefeet.

February 3: Rabbit sat in its cage with both hind feet extended backward. Its eyes had a peculiar staring look. It smelled of food when presented, but refused to eat.

February 4: The symptoms were aggravated since yesterday.

February 5: Rabbit on one side breathed regularly.

February 6: Found dead in the morning. Membrane of the brain slightly injected; the gray and white matter normal in appearance; ventricles normal. Spinal cord not visibly affected. Lungs hyperemic. Heart normal in color. The liver very dark; a microscopic examination showed a large amount of pigment. Spleen and kidneys normal. Slight venous injection of intestines. Tubes of agar inoculated from the various organs remained clear. Cover-glass preparations showed no microorganisms.

RABBIT No. 418.

Exhibited the same symptoms as rabbit No. 420. The post-mortem showed a marked hyperemia of the kidneys, otherwise not different from No. 420.

RABBIT No. 424.

March 2, twenty-one days after its inoculation, this rabbit was paralyzed in the hind limbs; could barely drag himself a few inches by using forefeet. Ate very little. Hitherto he appeared to be perfectly well.

March 3: Rabbit could not use his hind feet; otherwise appeared to be better than yesterday.

March 4: Rabbit was sitting up in usual position; paralysis much improved, but appeared to be in distress.

March 5: Rabbit found dead. The liver was very dark, containing pigment. Heart muscle unusually pale. Lungs slightly congested. The brain appeared to be normal.

RABBIT No. 433.

March 29: Twenty days after inoculation this rabbit appeared to be dull, but when placed on the floor would hop about slowly.

May 9: Head drawn back. Respiration slow. Died about 2 p. m. Mouth and fauces normal. Stomach contained partially digested food. Liver deeply reddened; contained much blood and pigment. Spleen normal. Kidneys pale, parenchymatous degeneration of cortex. Heart muscle unusually large; blood vessels injected. Lungs hyperæmic. The brain appeared to be normal.

RABBIT No. 9.

This rabbit exhibited its first sign of the disease on the sixteenth day. Its temperature was taken daily at 8 a. m. For the first sixteen days it was normal excepting on the ninth, twelfth, and fifteenth days, when it reached 104.8°, 104°, and 104.2° F., respectively.

May 26 (sixteenth day): Temperature 102.2° F. Rabbit had difficulty in using hind legs.

May 27: Temperature 101.5° F. Partial paralysis of hind legs in the afternoon.

May 28: Temperature 89.8° F. Lay on one side, but was able to move all four feet. Respiration slow but easy. Head was drawn slightly backward.

May 29: Rabbit unconscious. No reflex movement when touched. Respiration very slow. It died about 11 a. m. Mouth and pharynx normal. The blood vessels of the trachea slightly injected. In cephalic lobe of right lung there was a small necrotic area. The blood vessels of heart slightly injected. Lungs hyperæmic. Liver dark, containing much pigment. Kidneys pale, especially cortex. Brain normal in appearance.

RABBIT No. 449.

Fifteenth day: The temperature on the ninth day was 104.8° F. On the following day it was 103.8°; subsequently it was normal. The first symptom noticed was a marked inclination to sit close in one corner of the cage and to refuse to move.

June 20 (seventeenth day): Rabbit considerably excited; respiration accelerated. A noticeable loss of coordination in the hind limbs. Temperature 102.8° F. In the evening rabbit lay on one side unable to rise. When touched it moved its forefeet slightly.

June 21: Rabbit unable to move its feet. The head moved a little. Respiration easy. In the evening a slight tapping on its cage induced a feeble movement of the head. Otherwise paralyzed.

June 22: Rabbit remained the same as yesterday.

June 23: Respiration labored. A very slight movement of the head when the cage was tapped. A few movements of the lower jaw noticed.

June 24: No change from yesterday. When turned over a slight movement of the head noticed. Head drawn backward. Rabbit died about 6 p. m. Liver deeply reddened. Brain normal in appearance.

RABBIT No. 434.

This rabbit remained well for several days, when it showed signs of paralysis.

March 29: Rabbit appeared dull, moved only after much urging, and had very little use of hind legs. It failed rapidly during the morning. At 11 a. m. it was barely able to sit up; hind legs projected backward. At 4 p. m. it lay on one side; no movement of body visible, except slow respiration and occasional twitching of forefeet and nose.

March 30: Rabbit found dead in the morning.

The mouth and fauces normal in appearance. The liver much enlarged and engorged with blood. Examination showed much pigment. The spleen slightly enlarged and very dark colored. Heart muscle pale. Lungs hyperæmic. The blood vessels of the brain injected, giving the gray matter a faint pinkish tint. Ventricles normal in appearance.

RABBIT No. 458.

Rabbit appeared to be well for fourteen days. It then exhibited marked emaciation and scratched the bottom of its cage almost continuously. These symptoms continued for four days, when the rabbit was found lying on one side as if in a semi-comatose condition. A little later it was observed climbing about the cage and could walk without falling. A few hours later it was lying on one side. When disturbed it moved all four feet, but made no other effort to rise. Two hours later it was apparently unconscious. When touched with a stick it moved the forefeet very little and lay on one side as before. No visible change on the following morning, except that the respiratory movements were much more feeble. It died early in the evening.

Mouth and fauces normal. Blood vessels of heart and lungs hyperæmic. The liver very dark, containing much pigment. Brain appeared to be normal.

RABBIT No. 496.

This rabbit remained well for fourteen days. May 5 (the fourteenth day) it sat in one corner of its cage. When disturbed it showed slight nervousness, and if forced to move was uncertain in its steps; toward night movements became difficult—unable to walk naturally.

Mouth and pharynx normal. Liver deeply congested. Brain normal in appearance, except that at the point of inoculation there was a yellowish necrosed area about as large as a pin's head. No other lesions.

RABBIT No. 56.

On the twentieth day after inoculation the rabbit exhibited peculiar movements when disturbed; on the following morning it was partially paralyzed in the hind limbs. In the afternoon paralysis became complete in all four limbs. It lay on its abdomen with the head turned to the left. It remained in this position for about twenty-four hours, when it died. Liver very dark, otherwise organs appeared to be normal.

B.—Inoculation of cattle.

Animal number.	Virus used.	Method of inoculation.	Date of inoculation.	Date of death.	Time from inoculation until death.
Calf No. 19*.....	Brain of steer No. 3	Beneath dura.....	Nov. 20, 1892	Dec. 19, 1892	29 days.
Calf No. 239†.....	Brain of rabbit No. 424.	Subcutaneously right side of neck, 2 c. c. of emulsion.	Mar. 7, 1893	Apr. 6, 1893	30 days.
Yearling No. 241...	Suspension, brain of rabbit No. 424.	Beneath dura, 0.10 c. c.	do.....	Mar. 26, 1893	19 days.
Yearling No. 242.....	do.....	do.....	do.....	do.....	19 days.
Calf No. 238.....	Filtrate, brain suspension, yearling No. 242.	do.....	Mar. 27, 1893	do.....	Remained well.
Yearling No. 238...	Suspension, brain of yearling No. 242.	do.....	do.....	Apr. 14, 1893	18 days.
Yearling No. 249...	Suspension, brain of rabbit No. 436.	Subcutaneously 0.3 c. c.	May 10, 1893	do.....	Remained well.

* For notes see page 76.

† The calves were from 6 to 8 months old.

YEARLING NO. 241.

Female. Inoculated beneath dura with 1 c. c. of an emulsion of the brain of rabbit No. 424, March 7. She remained apparently well for fifteen days. March 22 she refused food and water. She was very uneasy, pressed her head vigorously against the sides of the stall, bellowed very frequently, more especially when a person was in sight. At times she pawed and stamped with the forefeet. On opening the door of the pen she made vigorous efforts to escape and did not notice either words or whip. In the yard she followed a person, pressing her nose forcibly against him, but not viciously. The bowels had been loose for two days (this was thought to have been due to the food given). Temperature, 103.8° F., taken every day at 8 a. m. Slight dribbling of saliva.

March 23: She ate and drank very little; temperature 100.3° F.; considerable diarrhea. Very uneasy; bellowed frequently. No rumination.

March 24: Temperature 102° F. Animal continued to press her head against the side of the stall, bellowing almost continuously. The presence of a dog produced no effect. Diarrhea continued; considerable tenesmus. She laid down frequently, often rose immediately, but at times would lie quietly for some minutes.

March 26: Temperature 99° F. Animal lying down, unable to get up. She died about 4 p. m.

Autopsy made March 27.—Post-mortem changes somewhat advanced. The intestinal tract appeared to be normal, excepting a few punctiform hemorrhages in pyloric portion of the stomach. Spleen normal. Liver and kidneys slightly discolored from decomposition. No lesions determined. Hypostatic congestion of right lung. Considerable edema about the heart. There were about 400 c. c. of a clear, dark, wine-colored liquid in the pericardial sac. No hemorrhages in the heart muscle, which was of a bluish color. Ventricles empty, dark blood clots in both auricles. The brain was somewhat soft, apparently due to post-mortem changes, otherwise normal in appearance.

CALF NO. 239.

Female. The animal remained apparently perfectly well until April 1, twenty-four days after its inoculation. On that day it refused all food. Small drops of perspiration had collected thickly on the hairs on the dorsal aspect of the body. Each breath was accompanied by a slight moan. The entire body in a tremble. Temperature 104.5° F., which hitherto has been normal.

April 2: Temperature 103.2° F. Refused food. Bellowed frequently without apparent cause. When approached she presented a surprised appearance, head elevated. In the evening she followed other calves, frothing at the mouth.

April 3: Temperature 103.8° F. Trembling of the entire body; stood with head erect, bellowing occasionally. When walking showed a marked loss of coordination in the hind legs, with unsteadiness in forefeet; considerable swaying from side to side. The forefeet were placed outward in a bracing position. Later in the day walking became impossible and she lay on one side, unable to get up.

April 4: Temperature 100.5° F. Lay on one side, with legs extended and head drawn backward. When approached slight movement of limbs and faint bleating; refused food, but drank about 3 quarts of water. Temperature in evening, 98.2° F.

April 5: Temperature 96.2° F. Lay perfectly quiet; no movement of body; raised head slightly when approached. Refused all food and water. Offered no resistance in being rolled over. Head drawn backward much more than normal. No retraction of the eyeballs; no trembling or twitching of the muscles. Toward night there was apparently complete paralysis.

April 6: Calf found dead early in the morning.

Autopsy.—Weight about 250 pounds. Condition good. The calf has lost very little flesh during sickness. When skinned considerable dark blood oozed from the cut ends of the veins. The spleen was much enlarged and dark colored, the normal markings nearly all obliterated. The blood vessels in the capsules injected. The liver was slightly enlarged. Capillaries filled with blood, which flowed freely upon section. Many of the liver cells in a state of fatty degeneration. The gall bladder contained about 100 c. c. of thick greenish, slightly viscid bile holding flaky muens in suspension. A slight congestion of the cortex of the kidneys, tubular epithelium granular, otherwise normal. Lymphatics normal in appearance.

The mouth, pharynx, larynx, and esophagus normal. The rumen contained considerable rather dry food. The omasum contained a normal quantity of food. The abomasum was empty, and the mucosa, excepting in the pyloric portion, deeply reddened. The mucosa of the duodenum deeply reddened with a few hemorrhagic areas and the contents blood stained. The mucosa of the jejunum and ileum sprinkled with small hemorrhagic areas. Contents blood stained. Cecum and colon nearly empty, the mucosa covered with a thin layer of whitish somewhat viscid mucus.

The trachea and bronchioles contained very little muens. The cephalic lobes emphysematous. The entire lungs had a bluish red color due to capillary injection. Upon section a small quantity of blood-stained serum oozed out of the cut vessels. A few punctiform hemorrhages on the pericardium. In left ventricle and auricle were firm dark clots which extend into the large blood vessels. In right side of heart were small clots also extending into larger blood vessels. The brain showed considerable pigment over frontal lobes. The blood vessels injected, especially in choroid plexus. Upon section small drops of blood oozed from the cut vessels. Ventricles normal. In certain of the cells from the gray matter peculiar highly refractive bodies were observed in the cellular protoplasm, outside of the nuclei. They were not observed to move in the myelinic fibers. In a few instances these bodies appeared to move. The spinal cord seemed to be normal.

A large number of tubes of agar were inoculated with brain tissue from various parts of that organ and with pieces of the other organs of the body. In one tube inoculated with the blood a few cultures of a streptococcus were obtained. It possessed no pathogenic effect on mice. All of the other inoculated tubes remained clear.

YEARLING No. 242.

Inoculated with an emulsion of a bit of the brain of No. 241. It manifested precisely the same symptoms as No. 241, but died about sixteen hours sooner. Its temperature varied from 100.8° F. to 103° F. for the first fifteen days. The last four days it was 102.6°, 103.8°, 103.8°, and 103.6°, respectively. The autopsy showed lesions similar to those found in No. 241. No bacteria were discovered in the organs.

CALF NO. 247.

A heifer about ten months old. Inoculated March 7. She remained well until April 7, when she refused food; otherwise no symptoms noticeable until April 11, when she had paroxysms of bellowing, and hooked and pawed her bedding considerably. Upon being approached she manifested a marked desire to press her nose against the individual. Temperature normal. She drank occasionally from a bucket of water in the stall. These symptoms continued for two days without change. There was a rapid loss of flesh.

April 13: In the morning she was noticed to froth at the mouth slightly and to be much more restless; bellowed frequently, but was not disturbed by the presence of a person. She occasionally drank a few swallows of water. Temperature 103.5° F. The eyes were normal in appearance. Considerable perspiration.

April 14: Heifer found dead in the morning. Examined about 2 p. m. The post-mortem changes considerably advanced. Areas of deeply reddened mucosa in the true stomach and intestines, especially cæcum and upper colon. Considerable whitish froth in trachea and bronchioles. Lungs not collapsed. About the base of the heart and along ventricular groove were many petechiae. Large, firm blood clots in both ventricles and auricles extending into the larger blood vessels. No lesions observable in the brain. The gray matter was somewhat softened, due presumably to post-mortem changes.

INOCULATION OF RABBITS AND A CALF WITH THE BRAIN OF A RABID DOG.

The virus for this series of inoculations was obtained from a rabid dog brought to the experiment station by Dr. Grenfell, of Washington, D. C., March 22, 1893. It had been affected for about three days and was killed the day following its arrival. A calf and two rabbits were inoculated by Dr. F. L. Kilborne with a suspension prepared by grinding a small portion of the medulla with a few cubic centimeters of sterilized bouillon. The calf and one rabbit were inoculated beneath the dura; the other rabbit was injected subcutaneously. In addition to these inoculations several others were made for diagnostic purposes from the brains of dogs suspected of rabies, or reported to be suffering from it. A considerable number of these died after exhibiting symptoms similar to those produced in animals after their inoculation with the brain of the dog first mentioned and which are recognized as diagnostic for rabies.

The more important data obtained in these inoculations are recorded in tabulated form, followed by a detailed account of the symptoms, and the lesions found in the different animals on post-mortem examination:

Inoculation of animals with the brains of rabid dogs.

Animals.	Virus used.	Method of inoculation.	Date of inoculation.	Date of death.	Period of inoculation.
					<i>Days.</i>
Rabbit No. 448.....	Brain of rabid dog No. 1	Beneath dura....	Mar. 24, 1893	Apr. 6, 1893	13
Rabbit No. 447.....	do	Subcutaneously....	do	Apr. 20, 1893	27
Rabbit No. 495.....	Brain of rabbit No. 447.	Beneath dura....	Apr. 21, 1893	May 2, 1893	11
Rabbit No. 481.....	Brain of rabid dog No. 2	do	Apr. 11, 1893	Apr. 28, 1893	17
Rabbit No. 59.....	Brain of rabid dog No. 3	do	June 20, 1893	July 8, 1893	18
Calf No. 249.....	Brain of rabid dog No. 1	do	Mar. 24, 1893	Apr. 3, 1893	10

RABBIT No. 448.

Inoculated beneath the dura with about 0.2 c. c. of an emulsion of the brain of a rabid dog, March 24, 1893.

April 4: Rabbit sat in one corner of its cage. When disturbed its skin quivered and it appeared to be excited; apparent loss of coordination; refused fresh green food.

April 5: Rabbit quiet. When disturbed it moved with difficulty. Eyes partially closed. It was rolled over on one side, when it struggled feebly to get up, but failed.

April 6: Rabbit paralyzed. Lay stretched out at full length, apparently dead; respiration very slow. It died later in the day.

Autopsy showed deeply reddened liver; blood vessels of the brain slightly injected; no other lesions.

RABBIT No. 447.

Inoculated subcutaneously with a suspension of brain of rabid dog (same as rabbit No. 448), March 24.

April 21: Rabbit found dead. Was not observed to be sick prior to death.

Autopsy showed a deeply reddened liver, due to blood stasis. Lungs partially collapsed. Brain anæmic. In order to determine the presence of rabies in this rabbit its brain was used for a subsequent inoculation which produced characteristic symptoms of rabies and fatal results.

RABBIT No. 495.

This rabbit remained well for eight days.

April 29: It exhibited unsteadiness in walking. Temperature 103.8° F.

April 30: Loss of coordination, especially in hind legs. Temperature 102.6° F.

May 1: Rabbit lay paralyzed on the bottom of its cage. Respiration rapid; pupils dilated and head drawn backward; later in the evening slow respiration was the only sign of life. Temperature 90° F.

May 2: Rabbit died about 7 a. m.

Autopsy.—Considerable viscid mucus in small intestines. In the ileum several small ulcers. Liver pale, very fatty. Blood vessels of the heart slightly injected. Mouth and fauces normal. Blood vessels of the brain slightly injected.

RABBIT No. 481.

This rabbit was inoculated with the brain of rabid dog No. 2.

April 27 (sixteen days after inoculation): The rabbit showed signs of paralysis in the hind legs early in the morning, but late in the afternoon the paralysis was nearly complete; respiration slow.

April 28: Complete paralysis. Very slight and slow respiratory movements. Rabbit died about 3 p. m.

Autopsy.—Much mucus in the small intestine. Liver very dark and contained much pigment. Mouth and pharynx normal in appearance. Blood vessels of the brain somewhat injected.

RABBIT No. 50.

This rabbit was inoculated with the brain of rabid dog No. 3. No symptoms observed until July 6 (sixteen days after inoculation), when it appeared to be uneasy; later in the day there was marked loss of coordination in the use of the hind legs.

July 7: Rabbit lay on the floor of the cage, unable to rise. Slight twitching of muscles when disturbed.

July 8: Complete paralysis. Respiratory movements barely perceptible. It died late in the afternoon.

Autopsy.—Liver dark, otherwise organs appeared to be normal.

This animal was inoculated beneath the dura with a suspension of the brain from rabid dog No. 1, March 24, 1893.

April 2: Calf was uneasy, eyeballs retracted, considerable frothing at the mouth. When approached it bellowed and endeavored to escape from the pen, seeming to be frightened. Temperature 101.8° F.

April 3: Calf became much excited while taking its temperature, which was accomplished after much difficulty, 105.4° F. being recorded. Calf had symptoms of convulsions; laid on one side; considerable trembling of muscles, and the head drawn back. Later it became partially paralyzed. Evacuation of bowels normal. It died early in the afternoon.

Autopsy.—Weight about 275 pounds; condition fairly good. Intestinal tract apparently normal throughout. Heart muscle sprinkled with a few punctiform hemorrhages. Dark blood clots in each of the heart chambers. Petechiæ beneath pleura over both lungs, considerable frothy mucus in the trachea and bronchioles. At the point of inoculation in the brain there was a slight necrosis of tissue, blood vessels slightly injected, otherwise brain and spinal cord normal in appearance. A rabbit inoculated with the brain from this calf died of rabies on the twelfth day subsequently.

The foregoing notes on the manifestation of the disease produced by the virus obtained from steer No. 4 in the Greene outbreak and from the brains of rabid dogs in the District of Columbia show that the inoculation diseases were identical. It has already been shown that the disease produced in rabbits with the brain of the steer was readily communicated to cattle by inoculation with the virus obtained from the affected rabbits, and, furthermore, the symptoms of the inoculated disease in the calves were similar to those manifested by the cattle which died in Mr. Wade's herd. A study of the symptoms shows that partial paralysis was usually the first indication of the disease. The average length of time which elapsed from the appearance of the first symptoms until death occurred was practically the same in both instances, but the average period of incubation was appreciably shorter in the rabbits inoculated with the dog virus.

The post-mortem appearances were practically the same in all cases; at least the differences observed in two animals inoculated with the same virus were quite as marked as those observed in rabbits inoculated with the virus from the different sources. It is important to note that the mouth, larynx, and intestinal tract usually presented a normal appearance. The enlarged and deeply reddened condition of the livers which contained much pigment was the only constant lesion observed.

The positive diagnosis of rabies, or a malady not distinguishable from it, in this outbreak of cattle disease is of much importance. As the animals were not furious the possibility of rabies was not entertained by the owner who had witnessed the furious form of the disease produced by the bite of rabid dogs.

This determination is furthermore significant in throwing light upon the probable nature of other outbreaks of a somewhat mysterious disease among cattle occasionally reported in the Western States. The

most serious of these on record is an outbreak which occurred in a herd of cattle pasturing on the bottom lands along the Des Moines River near Emmetsburg, Iowa, in 1891. Dr. Stalker tells me that the symptoms manifested and the post-mortem appearance of the affected animals in the two outbreaks were similar in every particular. Unfortunately rabbits were not inoculated with the brains from the animals examined at Emmetsburg. It is interesting to compare the conditions under which the two outbreaks occurred. In both cases the presence of rabid or strange dogs was not known. The cattle in the two affected herds were on lowland, better known, perhaps, as "slough" pasture. Although Mr. Wade's cattle were furnished well water, it is highly probable that the animals drank more or less of the stagnant water which remained throughout the season in pools between the bogs, as they were never driven from the lowlands to the watering trough. In the affected herd at Emmetsburg it is stated that the cattle were compelled to drink exclusively from a pond of stagnant water. It is a curious and most interesting fact that there were two other herds of cattle on the bottom lands of the Des Moines River at the same time, but they were driven daily to the river for water, and these two herds remained free from the disease. While the known facts in these outbreaks in no way demonstrate their identity, they suggest a striking similarity between them and indicate a possible relationship between the conditions under which the cattle were kept and the disease.

Until the specific cause of rabies is demonstrated we are able to recognize the virus in the brain substance of the affected animals only by its ability to reproduce the disease when properly inoculated into other animals. As shown in the inoculation experiments, the filtrate (through a bougie of a Pasteur filter) of a suspension of the brain substance of a rabid animal would not produce the disease, while the injection of the suspension was followed by characteristic symptoms and fatal results. This fact, which confirms the results of other investigators, indicates that the specific cause is not a soluble substance. The extensive bacteriological investigations made by several European workers indicate that the virus of rabies is not bacterial in its nature, and the presence of other microscopic organisms have likewise not been demonstrated. Several interesting facts concerning the nature of rabies were noted during the course of this investigation, but as they do not pertain to the diagnosis of the disease in this outbreak among cattle they are withheld for a future publication.

The results of this series of investigations indicate that rabies, or a closely related disease, sometimes occurs among cattle kept under certain conditions without the intervention of rabid dogs or other animals. A review of the voluminous literature on rabies shows that many supposed sporadic cases are recorded, and also considerable evidence that the bites of several species of animals have produced the disease. Until the specific cause of this malady is determined it is suggested that

cattle raisers should consider the possibility of its occurrence when they turn their cattle upon low, boggy pasture land.

Although a remedy is not known it is quite probable that if the animals are removed to high land as soon as the first deaths occur the amount of loss will be much less than if they are allowed to remain on the lowland throughout the season, especially when the disease appears early in the summer. This is indicated by the history of the outbreaks cited. Mr. Wade's cattle were removed early in the fall and the loss was only about 30 per cent, while at Emmetsburg it is stated that the cattle were not taken up until late in the fall, and the loss was very much greater.

LETTER OF SUBMITTAL.

SIR: I herewith submit the result of the examination of cornstalks supposed to be the cause of disease in cattle.

Respectfully,

E. A. DE SCHWEINITZ,
Chemist, Biochemic Laboratory, B. A. I.

Dr. D. E. SALMON,
Chief of Bureau of Animal Industry.

CHEMICAL EXAMINATION OF CORNSTALKS PRESUMABLY THE CAUSE
OF CORNSTALK DISEASE IN CATTLE.

By E. A. DE SCHWEINITZ.

In 1890 some cornstalks were brought to the laboratory for examination. These had been collected from a field in which a few cattle had died from the so-called cornstalk disease, and were supposed to be the cause of the fatal result. The leaves and stalks were covered with smut. This was carefully separated before the examinations were made. An extract from the stalks gave reactions which would indicate the presence of cholin. Although this has been found in a number of plants, so far as I know it has never been noted in this connection, nor was the quantity present sufficient to have produced any poisonous effects in animals feeding on the stalks.

In 1892 and 1893 Dr. Moore undertook a more extended study of the cornstalk disease in the field, and collected and forwarded for study several packages of stalks. These were examined by Mr. Emery, under my direction. The dried powdered stalks were first extracted with petroleum spirits, and the residue then extracted with alcohol acidified with 3 per cent hydrochloric acid. This extract upon evaporation was slightly charred, but the water extract of the residue gave a yellowish green precipitate with phosphomolybdic acid. The water solution was then made alkaline with soda and extracted with ether, but no reaction for alkaloids could be detected. The solution made acid and again shaken with ether gave a small quantity of a brown, oily substance. The latter, however, gave no alkaloid reactions and failed to produce any effect upon guinea pigs when fed to them in considerable quantity. The petroleum extract was also free from poisonous principles. Another lot of stalks, leaves, and a few ears of corn collected from a portion of a field where animals had become ill were examined. The stalks, husks, and kernels of this lot were all examined for alkaloids or poisonous principles, but failed to show any reactions, with the exception of a slight precipitate with phosphomolybdic acid.

Some corn smut carefully separated from the above leaves and stalks was next extracted with alcohol acidified with hydrochloric acid. The extract was concentrated, neutralized with soda, and shaken with ether. The ether extract was evaporated spontaneously and the residue taken up with acidified water. The following reactions were obtained in this solution:

Iodine in potassium iodide, a red-brown amorphous precipitate.

Phosphomolybdic acid, a dirty yellow amorphous precipitate.

Mayer's solution, a whitish amorphous precipitate.

The solution was then neutralized with soda extracted with ether, and the latter solution concentrated over sulphuric acid in vacuo. A very small quantity of an oily nonpoisonous residue was obtained.

Some of the leaves sent in by Dr. Moore were covered with dark spots due to a parasitic disease. The diseased portions were carefully cut out and examined for alkaloids or poisonous principles.

The oily residue from the smut and also that from this part of the stalks appeared to correspond to sclerotic acid, a principle which Dragendorff has extracted from ergot and which Parsons claims to have found also in *Ustilago* (corn smut). The quantity, however, obtained from the stalk would not be enough to account for the fatal effects in cattle unless a peculiarly susceptible condition of the animal existed at the time, or the improbable supposition that an excessively large amount of the poison was contained in the leaves and stalks that the animal happened to eat.

An enlarged and badly congested liver was also forwarded by Dr. Moore. This had been taken from one of the animals that had died supposedly from the cornstalk disease.

The liver was extracted with 90 per cent alcohol plus 20 per cent tartaric acid and the filtrate was evaporated in a vacuum pan. The residue was extracted with 95 per cent alcohol, and after reevaporation the residue was extracted with water. The solution gave a slight precipitate with phosphomolybdic and phosphotungstic acids, but no other alkaloidal reagents. The solution was then concentrated and mercuric chloride added in excess. After standing several days a precipitate was thrown down. This was filtered off and decomposed with sulphuretted hydrogen. After the mercury had been separated the residual solution gave a white curdy precipitate with phosphomolybdic acid. The filtrate from the mercuric chloride precipitate gave no reaction with alkaloidal reagents. The solution which gave a precipitate with phosphomolybdic acid was made alkaline with sodium hydrate and extracted with ether and chloroform. The water solution of the residue from these solvents gave a slight precipitate with phosphomolybdic acid but with no other reagent. It is true that this is the only reagent that gives a distinctive precipitate with sclerotic acid, but the precipitate here could scarcely be supposed to be due to the presence of this substance. The results of these examinations must be considered negative in character so far as the presence of an active poisonous principle is concerned.

The determination of the amount of ash in the cornstalks showed in the dry matter 6.4 per cent, and an examination was made for possible excessive quantities of nitrates.

Recently cattle have been found poisoned from cornstalks containing an unusual amount of potassium nitrate (Bulletin No. 44, Kansas experiment station). In the stalks, however, in which this was found the potassium nitrate could be detected by the eye in large crystals, and also by the taste. The particular stalks had been grown under peculiar conditions near the barn, where excessive amounts of nitrates could be absorbed. Those that we examined contained only a minute trace of the nitrate, so that if in any of the instances the cornstalks were the cause of disease in the cattle, and our samples were fair specimens, the poisoning was not by this salt. It should be remembered, however, that in all our examinations of the stalks the quantity used was small and not proportional to the amount cattle would eat. An apparently nontoxic principle under peculiar conditions might produce disastrous results.

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BULLETIN No. 11.

(Dairy No. 1.)

**U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.**

STATISTICS OF THE DAIRY.

**COMPILED FROM THE UNITED STATES CENSUS FOR 1890,
AND FROM OTHER RELIABLE SOURCES,
WITH EXPLANATORY NOTES,**

BY

**HENRY E. ALVORD, C. E.,
CHIEF OF THE DAIRY DIVISION.**

**Under the direction of
Dr. D. E. SALMON,
Chief of the Bureau of Animal Industry**



**WASHINGTON :
GOVERNMENT PRINTING OFFICE.
1896.**

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., December 7, 1895.

SIR: I have the honor to transmit herewith for publication a report of Maj. H. E. Alvord, Chief of the Dairy Division of this Bureau, covering the principal statistics relating to the dairy industry of the United States. The subject is an important one, and there is here brought together for the first time the statistical information which shows the development and the magnitude of this branch of American agricultural effort. It is information which every intelligent dairyman needs, and it is also designed as the foundation for much of the future work of the Dairy Division. Its prompt publication in an available form will be of much benefit to an industry which at this time is in great need of assistance.

Very respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY, DAIRY DIVISION,
Washington, D. C., November 21, 1895.

SIR: I have the honor to submit herewith for publication a compilation of the principal statistics relating to the dairy industry of this country, constituting the first publication of this division.

A part of the figures thus brought together are easily found, but, on the other hand, many of them are inaccessible to people generally. It is believed that the collection as presented will prove interesting and useful to many persons connected with dairying and form a suitable basis for future publications prepared by this division.

It is disappointing to find little data available as to the dairy interests of foreign countries. About all that can be obtained are the number of cows and other cattle. With a few exceptions, products are mere matters of estimate. Statistics of foreign markets for dairy products can be obtained, but these, together with the whole subject of exports, imports, and domestic markets, are reserved for a subsequent publication.

Yours, respectfully,

HENRY E. ALVORD,
Chief of Dairy Division.

Dr. D. E. SALMON,
Chief of the Bureau of Animal Industry.

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STATISTICS OF THE DAIRY.

By HENRY E. ALVORD, C. E., *Chief of Dairy Division.*

INTRODUCTORY.

OBJECT AND PURPOSE OF THE DIVISION.

The order establishing the Dairy Division in the Bureau of Animal Industry of the United States Department of Agriculture, to commence operations July 1, 1895, prescribes that "the object and purpose of this division will be to collect and disseminate information relating to the dairy industry of the United States, in such manner and to such extent as may be deemed most expedient and beneficial."

Information bearing upon dairying will be gathered from all reliable sources available, and classified and arranged at this office for future use. It is proposed to prepare publications of three classes: (1) Leaflets upon points in dairy practice, farm dairying, cooperative effort, organization, equipment, and management of creameries and cheese factories, and facilities for transportation and marketing; (2) bulletins upon dairy topics, somewhat more extended, giving latest information and most approved methods, gathered at home and abroad from expert dairymen, creameries, organizations, and the experiment stations and dairy schools; also, as to condition, changes, and needs of the dairy markets; (3) reports upon the results of special inquiries and investigations.

Among the subjects which will receive early attention and require considerable time are these: (1) The condition and demands of domestic markets for dairy products; (2) the milk trade; production and service for cities and towns; (3) imitations and substitutes for dairy products; and (4) the number and distribution of pure-bred dairy cattle and of grades, with their effects upon products and markets.

As a basis for intelligent work in the various lines indicated, it became necessary to gather and arrange the general facts as to dairying in statistical form. This bulletin has resulted from that endeavor.

CENSUS AND OTHER STATISTICS.

Upon the pages following are given most of the statistics which are available relating to the dairy in the United States, and some upon the

cattle and products of foreign countries. The facts connected with domestic trade and foreign commerce in dairy products are in process of compilation for a later publication.

The tables compiled are mainly from the Eleventh Census of the United States, for 1890, and are largely from proof sheets of unpublished volumes, courteously furnished by the Census Division of the Department of the Interior. With these are presented for comparison other figures from like authority, beginning with the Census of 1840, at which time the milch cows of the country were first enumerated. Some general farm statistics are also added which have a bearing upon the dairy industry or show its position with relation to other branches of agriculture.

It should be remembered that in census statistics all enumerations of persons, farms, animals, etc., are for the census year stated, but the figures for products of all kinds represent the returns for the agricultural year next preceding.

All statistics which are given for dates subsequent to the year 1890 are the estimates of this Department or of State officials or other authorities, whose courtesy is hereby acknowledged and who are respectively credited with the information furnished.

The miscellaneous statistics which relate to certain States, or to the country as a whole, are self-explanatory. They all have close connections with the dairy industry.

The text which precedes the principal tables consists of extracts from a report by Mr. John Hyde, now of the Department of Agriculture, late expert special agent in charge of agriculture of the Eleventh Census. This report or statistical analysis was prepared for the forthcoming agricultural volume of the census, and these extracts from the original manuscript are made by permission.

In connection with some of the tables there will be found further explanatory text. That which accompanies the table of cows and cattle of foreign countries includes some interesting comparisons with States of the Union, made by the Assistant Chief of the Dairy Division. Diagrams are used in some instances instead of figures alone, in order to present comparisons in a graphic form.

NEAT CATTLE ON RANGES.

Most of the agricultural statistics of the census were gathered from farms, and this excluded the wide Western areas or "range country," carrying some millions of neat cattle. These "cattle on ranges" were enumerated or closely estimated and separately reported. They numbered in all 6,285,200, distributed through ten States and Territories, as shown by the table. A very insignificant part of these animals could be properly called milch cows or dairy cows, and consequently the omission of these range cattle from the general tables has no appreciable effect upon the statistics of the dairy.

COWS ON FARMS NOT ALL DAIRY CATTLE.

The State of Texas has a little more than 1,000,000 cows reported on farms, and of its range cattle about 750,000 are cows. It is altogether probable that the larger part of these Texas cows "on farms" are beef-breeding animals as truly as those on ranges, and ought not to be included in the milch cows of the country. Table III shows the average annual milk product per cow to be 315 gallons for the whole United States, and 118 gallons for Texas. The same remarks apply to portions of the cows in some other States, but these would be comparatively few in the aggregate. Upon this basis of probable error the total number of milch cows in the United States should be reduced at least half a million. This would raise the average product per cow considerably. The only safe course in any computation, however, is to use the figures of the census as they are given.

COWS IN CITIES, TOWNS, AND VILLAGES.

For census purposes the farm was fixed at a minimum area of 3 acres, and hence the enumeration was omitted of all domestic animals held by occupants of smaller areas. This excluded all cows in cities, towns, and villages, and those owned by residents on small suburban lots. Many large milk-producing herds kept in town and city stables would belong to this excluded class. The total number of cows actually owned in the United States, but not included in the census tables, must be very large, probably exceeding a half million. There is no basis for any close estimate of the number of these animals, or of the quantity and value of their dairy products.

RELATIVE IMPORTANCE OF THE DAIRY.

In a classification of the various annual farm products of the country by values, meats and closely related products stand first in order, the corn crop second, dairy products and the hay crop alternate in the third and fourth places, and wheat occupies the fifth. Hay and corn are so largely tributary to the dairy, as raw materials for its support, that it is fair to place dairy products as second only to meat products in the general list.

(See Diagram A, at page 25.)

ESTIMATE FOR 1895.

At the close of the year 1895 the cows which may properly be regarded as dairy animals constitute about one-third of all the neat cattle in the United States, and are about 17,000,000 in number. Dividing these roughly according to their principal products, it may be considered that 11,000,000 cows are primarily butter producers, 1,000,000 cows produce all our cheese, and the milk from 5,000,000 cows is consumed by the families of their owners, or on the farms where produced,

or is sold to be consumed as milk, fresh or condensed. These estimates, with products and values added, may be tabulated as follows:

Cows.	Product.	Rate of product.	Total product.	Rate of value.	Total value.
<i>Millions.</i>					<i>Dollars.</i>
11	Butter ...	125 pounds ...	1,375,000,000 lbs ..	20 cents..	275,000,000
1	Cheese ...	280 pounds ...	280,000,000 lbs ..	8 cents..	22,400,000
5	Milk	350 gallons ...	1,750,000,000 gals..	9 cents..	157,500,000

This gives the grand total value of the dairy products of the country as \$454,900,000. If to this be added the skim milk, buttermilk, and whey, at their proper feeding value, and the calves yearly dropped, the annual aggregate value of the products of our dairy cows exceeds \$500,000,000. This is regarded as a conservative estimate, and does not include the manure product, which has a very large but quite uncertain value.

If the value, per head, estimated for cows in this country, viz, \$22 to \$25, is accepted, these animals produce nearly 50 per cent more than their own value, annually. But there is an old farm rule, which has reasonable basis, that a cow is worth whatever she will produce in a year, including her calf. At this rate the average value of the dairy cow in the United States must be about \$30.

The foregoing estimates are based upon an average yield of 350 gallons, or about 3,000 pounds of milk, yearly by each cow. This is rather more than shown by the census tables, but those exclude the large number of town cows, which would materially raise the average milk product. This rate of yield provides for butter and cheese product estimated and for consumption, besides the skim milk and buttermilk residue from the butter cows, about 25½ gallons of whole milk per annum per capita of our population. Two hundred and twenty pounds of milk for 365 days (rather more than one-half pint a day) is by no means an excessive allowance, but many people do not, in fact, approach that rate of consumption.

NEEDED IMPROVEMENT IN DAIRY CATTLE.

Assuming that the different products of the average dairy cow in America do not exceed much, if at all, the foregoing estimates, it is evident that the average cow of the country is far below a standard which is desirable and entirely practicable. The tables show that there has been a gradual improvement in the average cow product, especially during the last two or three decades. But the progress is by far too slow.

A very good annual average yield of milk is 5,000 pounds, instead of 3,000, and 200 to 225 pounds of butter per cow, instead of 125 pounds. Many herds kept in a plain, practical farm fashion attain still better results. There are manifestly many cows in the country, probably some

millions, that do not produce the value of their annual cost, however cheap and wastefully poor their keeping may be. It is apparent that if but two cows were kept, of the suggested standard of production, in place of every three of the existing average quality, the aggregate products of the dairy industry of the country would be increased more than 10 per cent, while the aggregate cost to their owners ought to be less, and probably would be.

Every possible influence should be exerted to induce dairy farmers to weed out their herds and keep fewer cows and better ones. At least, the average quality of cows kept for dairy purposes should be brought up to a respectable and profitable standard. For the present the cow owner may reasonably require something over 2 gallons of milk per day for four months, then 2 gallons a day for the next four, and at least two months more in milk during the year, with constantly decreasing yield. This provides for an annual average yield of 5,000 pounds of milk, or about 575 gallons, which is a fair ideal standard for the dairy cow in the United States.

**DISCUSSION OF THE AGRICULTURAL STATISTICS OF THE
ELEVENTH UNITED STATES CENSUS.**

By JOHN HYDE, *Expert Special Agent in Charge of Agriculture.*

[Extracts published by permission.]

NEAT CATTLE.

On June 1, 1890, the 4,564,641 farms in the United States contained 1,117,494 working oxen, 16,511,950 milch cows, and 33,734,128 other cattle—a total of 51,363,572.

On June 1, 1880, the 4,008,907 farms contained 993,341 working oxen, 12,443,120 milch cows, and 22,488,550 other cattle—a total of 35,925,011.

There is, therefore, an increase of 124,153, or 12.44 per cent, in the number of working oxen; of 4,068,830, or 32.70 per cent, in the number of milch cows, and of 11,245,578, or 50.01 per cent, in the number of other cattle, the increase in the total number of neat cattle on farms being 15,438,561, or 42.97 per cent.

On June 1, 1890, there were also 5,851,640 neat cattle on ranges (not including 433,580 in Indian Territory), of which 1,959,888 were cows and calves. On June 1, 1880, there was an estimated total of 3,750,022 neat cattle on ranges.

There is thus an apparent increase of 2,535,198, or 67.60 per cent, in the total number of neat cattle on ranges, and of 17,973,759, or 45.30 per cent, in the total number of neat cattle in the United States.

The State having the largest number of neat cattle on farms to every square mile of land surface is Iowa, where the average is 88.25, Illinois standing second, with an average of 54.70; Vermont, Connecticut, New York, Ohio, Indiana, and Missouri have between 40 and 50 neat cattle on farms for every square mile of land surface; Massachusetts, Rhode Island, Pennsylvania, Wisconsin, Kansas, and Oklahoma, between 30 and 40; New Hampshire, New Jersey, Delaware, Maryland, West Virginia, Nebraska, Kentucky, Tennessee, and Texas, between 20 and 30; Maine, the District of Columbia, Virginia, North Carolina, Georgia, Michigan, Minnesota, Alabama, Mississippi, Louisiana, and Arkansas, between 10 and 20; and South Carolina, Florida, North Dakota, South Dakota, Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, and California, under 10.

East of the Mississippi River it is only in the States of Vermont and Florida that there are 1,000 or more neat cattle on farms for every 1,000 of the population. West of the Mississippi River, however, the proportions are almost entirely reversed, there being few States or Territories west of that dividing line the number of whose neat cattle on farms is

not largely in excess of population. In Wyoming there are 11 neat cattle on farms to each inhabitant, while the addition of those on the ranges in that State would increase the ratio to more than 15 to 1.

STATISTICS OF QUALITY.

The statistics of quality having been collected in 1890 for the first time, no comparison can be made with previous censuses, and the interest that attaches to this portion of the report is confined to the amount and distribution of the improved stock of the country in 1890 and to comparisons between States or groups of States. Taking the country as a whole, 0.99 per cent of neat cattle on farms in 1890 were pure-bred, 16.08 per cent were grades, one-half blood or higher, and 82.93 per cent were common or native, including grades of less than one-half blood. The highest percentage of pure-bred cattle, 1.77, is found in the North Atlantic Division, which has also 16.41 per cent of grades, making 18.18 per cent of its 5,461,724 neat cattle one-half blood or over. The North Central Division has a smaller percentage (1.21) of pure-bred, but its percentage of grades is 22.21, its total percentage of more than half-blood being thus 23.42. It is certainly a significant fact that of the large total of 24,572,400 neat cattle on farms in this division nearly one-fourth are of this high standard of quality. The South Atlantic Division has 0.73 per cent of pure-bred and 7.41 per cent of grades, and the South Central Division 0.46 per cent of pure-bred and 6.77 per cent of grades, while the Western Division, with only 0.52 per cent of pure-bred, appears, nevertheless, with 14.39 per cent of grades, owing to the exceedingly large proportion of grades reported from certain districts in Colorado, the figures for which could not be verified, nor was there, on the other hand, sufficient warrant for their modification. While the error, if any, will probably have affected the percentages of grades and common stock in the Western Division, the number of cattle involved was not sufficiently large for it to have had any appreciable effect upon the percentages for the United States as a whole.

Examining the statistics of quality by States and Territories, it is found that the highest percentage of pure-bred (5.97) was in the District of Columbia, and the highest percentage of grades, 29.90 (excluding Colorado, for the reasons stated), in Iowa, the highest percentage of pure bred and grades combined (again excluding Colorado) being in Rhode Island, where 31.47 per cent of neat cattle on farms were half-blood or upward. There is, however, very little difference between Rhode Island and Iowa in this regard, the percentage in the latter State being 31.13. Among the North Atlantic States, Connecticut, Rhode Island, Massachusetts, and New Jersey have all over 3 per cent of pure-bred, and all of these, with the exception of New Jersey, have a very high percentage of grades. Maine and Vermont have a high percentage of grades, with a percentage of pure-bred differing but little from the average of the division as a whole. New York and New

Jersey have each only 1.50 per cent of pure-bred, while they have 15.39 and 11.68 per cent of grades, respectively. In the South Atlantic Group the percentage of pure-bred ranges from 5.97 in the District of Columbia and 2.33 in Maryland to 0.45 in Georgia and 0.25 in Florida; the percentage of grades ranging from 23.58 in the District of Columbia and 18.62 in Delaware to 3.22 in Georgia and 1.24 in Florida. The last-mentioned State appears to have the smallest number of improved stock in proportion to the total number of its neat cattle on farms of any State or Territory in the entire country. The percentage in the Carolinas and Georgia is also exceedingly low. Among the North Central States, Ohio has the highest percentage of pure-bred, but is exceeded both in percentage of grades and in that of pure-bred and grades combined by Iowa. Considering the systematic efforts that have been made to improve the quality of the neat cattle of Minnesota during recent years, it is somewhat surprising that that State should have a smaller total percentage of pure-bred and grades of one-half blood or upward than any other State in the division to which it belongs. The difference, however, between Minnesota, South Dakota, North Dakota, and Wisconsin is very small. There is a wide difference between the percentages in the various States composing the South Central Division—Kentucky having 1.52 per cent of pure-bred and 14.77 per cent of grades, while Louisiana has only 1.98 per cent of pure-bred and grades combined, the percentages in Arkansas, Alabama, and Mississippi being almost equally low. With the exception of Colorado, the States and Territories of the Western Division deviate less from the general average of the entire division than do the States of any other group. Marked differences, however, there certainly are, Utah having 1.25 per cent of pure-bred, as compared with 0.10 per cent in New Mexico and 0.08 per cent in Arizona, and California having 16.93 per cent of grades, as compared with 4.66 per cent in Idaho.

MILCH COWS ON FARMS.

The increase in the number of milch cows on farms between 1880 and 1890 is the largest ever reported, and in 1890 the number to every 100 of the population (26.4) was greater than at any census since 1860. At the censuses of 1850, 1860, 1870, and 1880 the number of milch cows reported as on farms was 6,385,094, 8,585,735, 8,935,332, and 12,443,120, respectively, the number per 100 of the population ranging from 23.2 in 1870 to 27.5 in 1850. This is a remarkably narrow range of fluctuation for five decennial censuses. Under normal conditions, however, the increase in the number of milch cows may be expected to keep pace with the increase of population, and it is interesting to note that out of 49 States and Territories, including the District of Columbia, 43 show an increase and only 6 a decrease between 1880 and 1890, the total increase in the 43 being 4,146,357 and the total decrease in the 6 only 77,527.

In the North Atlantic Division, a division which shows a decrease in the number and area of its farms and in many important branches of agriculture, every State had a larger number of milch cows in 1890 than in 1880. In Pennsylvania the increase was 73,098, in New Jersey 9,498, in New York 2,375, and in the six New England States 75,345, Massachusetts taking the lead with an increase of 21,611. The increase in this division, however, has not kept pace with the growth of population, the increase in the number of milch cows being only 5.02 per cent, while that of population was 19.95 per cent. While New York had a larger number of milch cows than any three other States in the division, not excluding even Pennsylvania, the ratio of milch cows to population was much the highest in Vermont, there being 696 to every 1,000 of the population in that State. In Franklin County, Vt., there were as many as 1,077 milch cows to every 1,000 of the population.

In the South Atlantic Division the largest increase is in Florida, which has 269 milch cows in 1890 for every 100 in 1880. West Virginia, Virginia, Maryland, and Delaware also show an increase. On the other hand, South Carolina and Georgia show a considerable decrease, especially the former; North Carolina and the District of Columbia also reporting a smaller number than in 1880. The decrease in South Carolina and Georgia, and to a less degree that in North Carolina, are especially noteworthy, not merely because the decline is considerable, but because these States form the only important exceptions to that increase in the number of milch cows which is reported from almost every part of the country. That the decrease in these States was more or less general is evident from the fact that in Georgia 77 counties show a decrease as compared with 60 showing an increase; in North Carolina 55 show a decrease as against 40 showing an increase, while in South Carolina 26 show a decrease and only 6 an increase. Taking the division as a whole, there is an increase of 88,705.

The North Central Division witnessed during the decade ending with 1890 an exceedingly large increase in the number of its milch cows and, as will be shown hereafter, a remarkable development of its dairy industry. The total number of milch cows reported as on farms in the 12 States comprised in this division is 8,240,999—49.91 per cent of the total number in the United States, and an increase of 2,838,918 upon the number reported from these 12 States in 1880. In Iowa, the division contains a State that has increased its number of milch cows by 644,231, and that has at length wrested from New York that primacy of position with respect to the number of milch cows and the total production of butter on farms and in factories which the latter State had so long maintained. In Iowa there are no fewer than 32 counties in which there are more than 1,000 milch cows for every 1,000 of the population, Delaware County standing at the head of these and all other counties in the United States with the high average of 1,630 to 1,000. In view of the greatly diminished area both of farms generally and of improved

land in Illinois since 1880, the large increase in the number of milch cows in that State, 221,973, or 25.63 per cent, is especially noteworthy. The increase and percentage of increase in Wisconsin, Minnesota, Kansas, and Nebraska have, however, been even greater than in Illinois—Wisconsin showing an increase of 314,246, or 65.69 per cent; Kansas an increase of 323,453, or 77.32 per cent; Minnesota an increase of 318,363, or 115.54 per cent, and Nebraska an increase of 343,858, or 213.32 per cent. The increase in the Dakotas amounts to 257,957; these States reporting more than seven times as many milch cows in 1890 as were contained in the Territory of Dakota in 1880. There has also been a large increase in Michigan and Missouri, a smaller one, but one more commensurate with the growth of population, in Indiana, and an increase of 3.62 per cent, or less than one-fourth of that of population, in Ohio.

In the South Central Division, also, every State shows an increase, the additions to the numbers reported in 1880 ranging from 20,645 in Alabama and 20,769 in Louisiana to 397,263 in Texas. In Tennessee, Alabama, Louisiana, and Arkansas the increase has failed to keep pace with the growth of population, and that such has not been the case with the division as a whole is due to the very large increase (65.54 per cent) in Texas. A noteworthy feature of the statistics for this division is the comparative uniformity in the number of milch cows to every 1,000 of the population in three of the principal States, Kentucky having 196, Tennessee 195, and Alabama 193 milch cows for every 1,000 of their inhabitants. In Texas the average is as high as 449 per thousand, while in Louisiana it is only 149 per thousand.

In the Western Division there is a remarkable correspondence between the increase in population and the increase in the number of milch cows, the former amounting to 71.27 per cent and the latter to 70.76 per cent. With the exception of Arizona and Nevada, which show a decrease (the latter also showing a decrease in population), every State and Territory in this division contained a larger number of milch cows in 1890 than in 1880. In Utah the increase was more than two-fifths, and in Colorado and California more than one-half. The number in Oregon almost doubled, in Montana and Idaho it more than doubled, and in Wyoming it trebled, Washington, also, having a large increase amounting to 156.03 per cent. Only in California, however, was the increase in the decade as much as 100,000 or did the total number reported in 1890 reach 300,000 or even one-half of that number, and the total number of milch cows on farms in the whole of this vast region, comprising considerably more than one-third of the total land surface of the United States, was less than one-half the number in Iowa. At the same time the ratio of milch cows to population was higher in this division than in either the North Atlantic or South Atlantic Division.

DAIRY PRODUCTS.

The total production of milk on farms in the United States in the year ending December 31, 1889 (not including farms of less than 3 acres, except where \$500 worth of the produce of the farm had been actually sold during the year), was 5,209,125,567 gallons, equivalent to 315½ gallons for each milch cow reported on June 1, 1890, and to 83 gallons per head of population.

The total production of butter on farms (as above defined) in the year ending December 31, 1889, was 1,024,223,468 pounds, as compared with a total of 777,250,287 pounds in 1879, and the total production of cheese 18,726,818 pounds, as compared with a total of 27,272,489 pounds in 1879, an increase of 246,973,181 pounds, or 31.78 per cent, in the production of butter on farms, and a decrease of 8,545,671 pounds, or 3 per cent, in the production of cheese on farms.

MILK PRODUCTION.

There are few, if any, products of agriculture, using that term in its widest application, the average rate of production of which varies more widely among the different States and Territories than does that of milk. As a general but not invariable rule the average production per milch cow has a certain correspondence with the report as to quality, the District of Columbia, which has the highest percentage of pure-bred cattle in the United States, having the highest average milk production, 533 gallons for each milch cow, while New Mexico, with the lowest percentage of pure-bred cattle, has the lowest average production of milk, only 38.75 gallons per milch cow. The proximity of a market for milk or dairy products is, however, a factor not entirely to be lost sight of in this connection.

Taking the country by grand divisions, the North Atlantic Division, with the highest percentage of pure-bred cattle, has the highest average milk production, 428.44 gallons per milch cow. The variation in the averages in this group of States is not great, the highest average production being 479.94 gallons in Massachusetts and 460.98 gallons in New York, and the lowest 368.58 gallons in Maine and 389.62 gallons in New Hampshire. The next highest divisional average is that of the North Central Division, which stands second also in its percentage of pure-bred cattle. Here the general average is 329.99 gallons, Michigan and Ohio having the highest average, 451.23 gallons and 411.31 gallons, respectively, and Missouri and Kansas the lowest, 227.87 gallons and 271.79 gallons, respectively. In the South Atlantic Division the general average is 242.23 gallons, the District of Columbia and State of Delaware having the highest averages, 533 gallons and 328.46 gallons, respectively, and the States of Georgia and Florida the lowest, 181.55 gallons and 44.60 gallons, respectively. In the South Central Division the general average is 183.66 gallons, the highest being 325.08

gallons in Kentucky and 311.77 gallons in Tennessee, and the lowest 77.03 gallons in Louisiana and 92.16 gallons in Oklahoma. The statistics of the Western Division present several noteworthy features. Among them is a remarkable variation in the average production per milch cow, as between one State or Territory and another, such production ranging from 38.75 gallons in New Mexico to 350.54 gallons in California. Another is the comparatively high average production in some of the new and sparsely populated States, Wyoming and Montana having averages of 262.29 gallons and 250.10 gallons, respectively. The production per capita of population in these States is, however, much below the general average for the United States, and, as is evident from the report, more than one-half of the total milk production of Montana and not far from one-half of that of Wyoming were used in the production of butter and cheese on farms.

The total production of milk in the United States in 1889, compared with the total population in June, 1890, gives an average of about 83 gallons for each inhabitant. The ratio was the highest in the North Central Division, where it was 122 gallons per unit of the population, the States comprised in this division producing, as will be shown hereafter, more than one-half the butter and one-third of the cheese made in the United States, both on farms and in factories. The ratio of milk production to population in the North Atlantic Division was nearly 83 gallons for each inhabitant, in the Western Division it was not quite 67 gallons, while in the South Atlantic and South Central divisions it was 37 gallons and 47 gallons, respectively.

The only States in which the production of milk amounted to 100 gallons or upward per capita of population were New Hampshire, Vermont, and New York in the North Atlantic Division, and Michigan, Wisconsin, Minnesota, North Dakota, South Dakota, Iowa, Nebraska, and Kansas in the North Central Division. Only in Vermont and Iowa was there a production of 200 gallons or upward for each inhabitant. The average in the District of Columbia is less than 2 gallons per capita, the city of Washington deriving its milk supply, mainly, from the States of Maryland and Virginia. In New Mexico the production was less than 5 gallons per capita of population; in Louisiana and Arizona it was under 12 gallons, and in Florida under 13 gallons for each inhabitant.

BUTTER PRODUCTION ON FARMS.

The most noteworthy fact in connection with the production of butter on farms is that, notwithstanding the great extension of the creamery system and the decline in the amount of butter annually exported, such production has increased even more rapidly than population. To go back to the census of 1850, it is found that the total production of butter on farms in 1849 was 313,345,306 pounds, or 13.51

pounds per capita of population. In 1860 the amount reported was 459,681,372 pounds, or 14.62 pounds per capita. In 1870 the amount reported was 514,092,683 pounds, which gave an average of only 13.33 pounds for each inhabitant. Up to this time there had been no creamery butter reported, but in 1880 the production of farm butter averaged 15.50 pounds for each inhabitant, and that of creamery butter 0.58 pound for each inhabitant, the total average being thus 16.08 pounds. At the Eleventh Census, however, the production of butter on farms alone averaged 16.33 pounds per capita of the population, and such had been the increase in the production of butter in creameries that the total production of butter averaged no less than 19.24 pounds per unit of the population.

The complete statistics of the production of butter in creameries, or factories, as such establishments are designated for census purposes, will be found in the report on manufactures, and they are referred to in this connection merely for the purpose of emphasizing the remarkable increase in the production on farms.

The increase in the production of farm butter, as distinguished from that made in creameries, has been very general, 39 States and Territories, considering the two Dakotas as a unit for convenience of comparison with the statistics of 1879, reporting an increase, and only 8, including the District of Columbia, a decrease. It is a significant fact that the whole of the States from which a smaller production of farm butter is reported than at the Tenth Census belong to the North Atlantic Division. Every other portion of the country shows an increase in its production of butter on farms, and, as a rule, the States that have witnessed the greatest extensions of the creamery system, such as Wisconsin, Minnesota, Iowa, and Nebraska, show also the greatest increase in the production of butter on farms. The North Central Division, which appears from the report on manufactures to have produced 72.03 per cent of the total production of creamery butter, produced 50.83 per cent of the total amount of farm butter, and its production, both on farms and in creameries, per capita of the population, is much higher than that of any other of the five grand divisions of States. That concentration of production, which has always been a distinguishing feature of American agriculture, has a remarkable exemplification in the case of butter, an article, the production of which, to a greater or less extent, is almost as general as is its consumption, but more than one-half of whose total production in the United States has, nevertheless, to be credited to 7 States, and almost one-fourth more to 7 others. It should, however, be remembered that the States of principal production are, with a few exceptions, those in which the creamery industry has attained its largest development.

In the production of butter on farms per capita of population, Vermont is far in the lead, its *average being 70.14 pounds*. On the other hand,

the production on farms and in factories combined was under 10 pounds in Washington, under 9 pounds in Montana, Colorado, and Utah, under 8 pounds in Wyoming, under 7 pounds in New Jersey, under 5 pounds in Massachusetts, and under 4 pounds in Rhode Island, for each inhabitant, while in some of the States in which there are no creameries the average production per capita is still smaller, Florida reporting less than 3 pounds and Louisiana and Arizona less than 2 pounds, and New Mexico less than 1 pound for each inhabitant. Of the States in which the production of butter on farms and in creameries is of the greatest importance, relatively to population, Vermont has a production of over 80 pounds per capita, Iowa of over 60 pounds, South Dakota of over 40 pounds, and Wisconsin, Minnesota, North Dakota, Nebraska, and Kansas of over 30 pounds.

Attention has already been called to the large increase in the number of milch cows. The increase in the production of butter per capita of population is, however, due, not alone to the increase in the number of cows, but in no inconsiderable degree to the general stimulus that not only the creamery system, but also the dairy industry, as distinguished from the creamery, is known to have received during the decade ending with 1890, and the result of which is seen in the fact that, while the average production of butter on farms and in factories at the Tenth Census was 64.83 pounds for each milch cow, the average production at the Eleventh Census was 72.98 pounds, an increase of 12.57 per cent. That this is not due directly, if at all, to the extension of the creamery system is shown by the fact that nearly all the States that have witnessed the greatest extension of that system during the decade ending with 1890 show a smaller average production of butter per milch cow than at the Tenth Census, and that many of the leading Southern States that contain no creameries whatever show a remarkable increase in the average production of butter per milch cow, such increase ranging from 50.36 per cent in Mississippi and 52.56 per cent in Arkansas to the increase in Louisiana, where the average production has almost doubled, and in South Carolina and Georgia, where it has more than doubled. In this connection, however, it is important to note that from a considerable number of counties in the South, especially in Georgia, a butter production is reported far in excess of the maximum butter-producing capabilities of the entire milk production of such counties. While this apparent error on the part of enumerators can not but affect, to a greater or less extent, both the total production, either of milk or of butter and the averages for such counties and even for the States in which they are contained, it is not sufficiently general to alter the fact that there has been an increase in the production of butter on the farms and plantations of the Southern States far out of proportion to the increase in the number of milch cows.

PRODUCTION OF CHEESE ON FARMS.

If a reference to the production of butter in creameries is necessary to a proper consideration of the statistics of the production of butter on farms, much more is a reference to the production of cheese in factories necessary to a proper understanding of the statistics of the production of cheese on farms, for while nearly 6 times as much butter is made on farms as in creameries, nearly 13 times as much cheese is made in factories as on farms, and while the production of cheese on farms shows a decrease of nearly one-third, such decrease is more than doubly offset by the increase in the production of cheese in factories. It is exceedingly interesting to observe how the production of cheese on farms has gradually given place to the factory system and how the remarkable change that has been brought about is shown in the statistics of successive censuses. In 1850 there was a reported production of cheese on farms amounting to 105,535,893 pounds; in 1860 the amount reported was 103,663,927 pounds; in 1870 it was 53,492,153 pounds; in 1880, 27,272,489 pounds, and in 1890, 18,726,818 pounds. The reported production in factories began with \$67,210 worth in 1850, which was followed by \$23,500 worth in 1860, the only decrease ever reported. In 1870 the factory production amounted to 109,435,229 pounds, in 1880 to 215,885,361 pounds, and in 1890 to 238,013,565 pounds.

The largest decrease and percentage of decrease in the production of cheese on farms during the decade ending with 1889 was in the States composing the North Atlantic Division, every one of which has a diminished production, whether the industry is one of considerable importance, as in New York, or of but minor importance, as in Rhode Island and New Jersey. This is not due to the extension of the factory system, as the production of cheese in factories also shows a decrease. In the North Central Division, likewise, the production of cheese on farms was considerably less in 1889 than in 1879, Minnesota, Missouri, the Dakotas, Nebraska, and Kansas forming the only exceptions to the rule. While, however, there has been a remarkable development of the factory system in this division, such extension has been by no means general, Ohio, Indiana, and Illinois showing a diminished production, both in factories and on farms. While in 1879 Ohio and Wisconsin each reported over 2,000,000 pounds, and Illinois and Iowa each over 1,000,000 pounds of cheese made on farms, an amount in excess of 1,000,000 pounds is reported for 1889 only by Ohio and Iowa. As in the case of the creamery system of butter-making, this division, the North Central, is the one that has witnessed during the decade the greatest extension of the cheese-factory system, Wisconsin alone having increased its production of cheese in factories over that reported at the Tenth Census by upward of 36,000,000 pounds (see report on manufactures).

But little cheese is made in the South, the total production on farms of the South Atlantic and South Central divisions being only 589,658 pounds in 1889 and 567,841 pounds in 1879, while the total production in factories fell from 349,147 pounds in 1879-80 to 78,800 pounds in 1889-90. Of the production on farms, Virginia and Texas each contributed over 100,000 pounds. On the other hand, the combined farm production of South Carolina, Florida, Alabama, Mississippi, and Louisiana was only 19,175 pounds, and none of these last-mentioned States reports any production in factories.

In most of the States and Territories of the far West cheese-making on farms gives evidence of having received a decided impetus during the decade, New Mexico producing nearly twice, Nevada nearly 3 times, Wyoming over 5 times, Colorado over 8 times, and Idaho over 10 times as much cheese on farms in 1889 as in 1879. Utah, Oregon, and California also show a large increase, the increase in Utah, however, being more than offset by the diminished production of its factories. Montana and Arizona not only report a smaller production on farms than at the Tenth Census, but are no longer to be credited with any production whatever in factories.

The total production of cheese on farms and in factories per capita of population was not only less in 1889-90 than in 1879-80, but even less than in 1849-50. In Wisconsin this total production in 1889-90 averaged 33.7 pounds for each inhabitant, in New York 20.7 pounds, and in Vermont 18.6 pounds. For the entire country, however, the average per capita of population was only 4.10 pounds, of which less than 5 ounces represented the production on farms. Only in California, Idaho, Vermont, Nevada, and Maine did the production on farms average 1 pound or upward for each inhabitant.

In connection with the relative decline of cheese-making in the United States, of which there is further evidence in the fact that the total production per milch cow in 1889-90 was 4 pounds less than in 1879-80, reference may be made to the fact that the total exports of cheese in the fiscal year ending June 30, 1890, were only 95,376,053 pounds as compared with a total of 127,553,907 pounds in the fiscal year ending June 30, 1880. Whether the shrinkage of exports, which was gradual, was due to a similar gradual diminution of the amount available for export after the requirements of the country had been supplied—the consumption per capita increasing while the production per capita was decreasing—or whether the relatively slow growth of the industry was due, wholly or in part, to a gradually decreasing foreign demand, it does not come within the scope of the census to determine.

GENERAL AGRICULTURAL STATISTICS.

TABLE I.—Farm and dairy statistics of the United States.

	From the United States Census of—				
	1890.	1880.	1870.	1860.	1850. ^a
Population	62,622,250	50,155,783	38,558,371	31,443,322	23,191,876
Occupations:					
Total persons reported	22,735,601	17,392,000			
Number in agriculture	8,460,251	7,670,493	5,922,471	3,221,574	2,400,583
Farms:					
Total number	4,584,641	4,008,907	2,659,985	2,044,077	1,449,075
Area, total	623,218,619	536,081,835	407,735,041	407,212,538	293,560,614
Acres unimproved, percent- age	42.6	46.9	53.7	59.9	61.5
Average size	137	134	153	199	203
Number cultivated by owner	3,269,728	2,984,306			
Number rented for money	454,659	322,357			
Value land, buildings, etc., dollars	13,279,252,649	10,197,096,776	9,262,803,861	6,645,045,007	3,271,575,426
Value implements and ma- chinery	494,247,467	406,520,055	336,878,429	246,118,141	151,587,638
Value livestock, all kinds, dol- lars	2,208,787,573	1,500,384,707	1,525,276,457	1,089,329,915	544,180,516
Value farm products, an- nual (b)	2,460,107,454	2,212,540,927	2,447,538,658		
Cattle:					
Milk cows	16,511,950	12,443,120	8,935,332	8,585,735	6,385,094
All others on farms	34,851,622	23,482,391	14,885,276	17,034,244	11,393,813
Cows to every 1,000 of population	264	248	232	273	275
Milk, total produced on farms, gallons	5,209,125,567	530,129,755	235,500,599	(c)	(c)
Butter made on farms (d)	1,024,223,468	777,239,287	514,092,683	459,681,372	313,345,306
Cheese made on farms (d)	18,728,818	27,272,489	53,492,153	103,663,927	105,535,893
Creameries, cheese factories, etc.:					
Number (e)	4,712	3,932	1,313	5	8
Butter made in same (d f), pounds	181,284,916	29,421,784			
Cheese made in same (d f), pounds	238,035,065	215,885,361	109,435,229		
Condensed milk	37,926,821	13,043,207			
Capital employed	16,624,163	9,604,803	3,690,075	13,400	11,950
Employees	14,921	7,903	4,607	13	55
Wages paid, annual	5,390,705	1,546,495	706,566	3,080	11,676
Cost of materials	51,364,574	18,363,579	14,089,284	10,791	54,419
Value of products	62,686,043	25,815,963	16,771,665	23,500	67,210
Total dairy products of United States (g), value	411,976,522	391,131,618	360,828,000	240,400,580	166,193,144

^a The Sixth United States Census (1840) gives number of milk cows, 4,837,043; value, \$72,555,000; value of dairy products for year, \$120,926,075.

^b The value of farm products for 1869 (census of 1870) included "betterments and additions to stock," so that in products only there was an actual increase in 1880, as compared with 1870. The total value of 1890, compared with 1880, showed only slight increase, although increase in the products themselves was very great; rapid decrease in market prices accounts for this difference.

^c No returns of milk product were made for 1850 and 1860. The great variation in the figures given results from these facts: In 1870, only "milk sold from farms" was reported, thus omitting all consumed on farms and there made into butter and cheese; in 1880, "milk sold or sent to butter and cheese factories" was included, again excluding home consumption; in 1890, the returns endeavored to show the total quantity of milk produced on farms.

^d To butter and cheese made on farms must be added that made at creameries and cheese factories to get the total product of the country (see Table III). The progressive increase in the production of butter and cheese in the United States, and the ratio of farm and factory product, is graphically shown by Diagram C.

^e The establishments reported for 1850, 1860, and 1870 were all cheese factories. The figures for 1850 are approximately correct, but those for 1860 are not; more cheese factories are known to have been in active operation in that year in the State of New York alone.

^f The butter and cheese made in creameries and factories in 1889 (census of 1890) does not include the products of urban establishments (see Table IV).

^g The total values of dairy products do not include the milk of "town cows" or cows not on farms, and the amounts given are thus much below the whole truth.

-Relative values of principal farm products of the United States in 1859,
1879, and 1889.

1859



1879

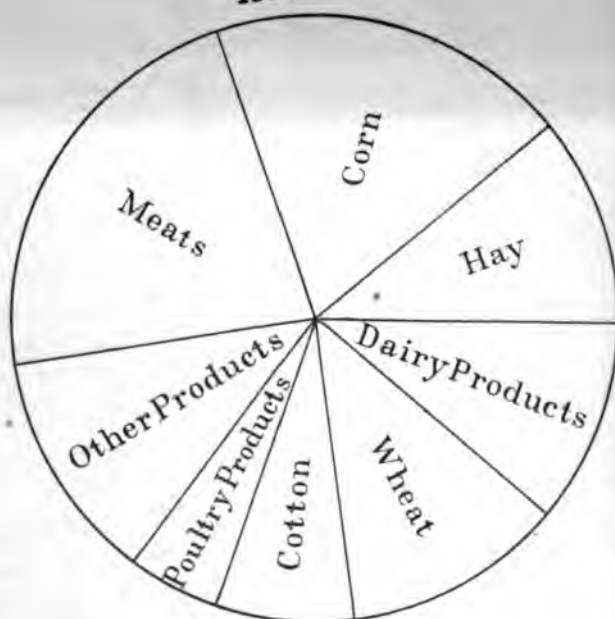


DIAGRAM A.—Relative value of principal farm products of the United States in 1859, 1879, and 1889.

1889

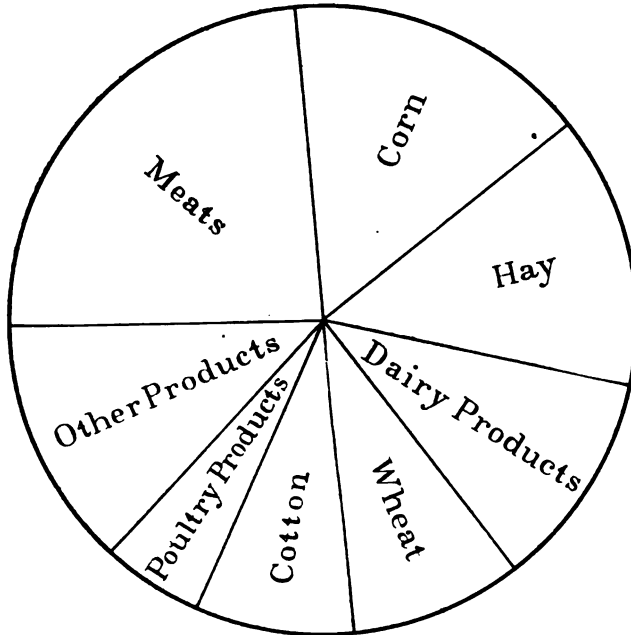


Diagram A shows, graphically, the relative values of important farm products for the years 1859, 1879, and 1889. Some important products are omitted in this comparison because their values can not be obtained. Dairy products increased only a little in the last decade, but their increase in value was practically in the same ratio as that of all the other stated products combined.

Value of principal farm products of the United States.

Products.	1859.		1879.		1889.	
	Per cent.	Total value.	Per cent.	Total value.	Per cent.	Total value.
Meats	17.9	\$300,000,000	22.1	\$800,000,000	23.9	\$900,000,000
Corn	21.6	360,680,878	19.2	694,818,304	15.9	597,918,829
Hay	9.1	152,671,168	11.3	409,505,783	14	526,632,062
Dairy products	14.4	240,400,580	10.8	391,131,618	11	411,976,522
Wheat	7.5	124,635,545	12.0	430,968,463	9.1	342,491,707
Cotton	12.6	211,516,625	7.5	271,636,121	8.2	307,008,114
Poultry	4.5	75,000,000	5	180,000,000	5.3	200,000,000
Other products (a)	12.4	206,639,527	12.1	440,438,353	12.6	472,492,249
Grand total	100	1,671,544,323	100	3,624,498,642	100	3,758,519,483

(a) "Other products" include barley, buckwheat, flax fiber, flaxseed, hemp, hops, Irish potatoes, leaf tobacco, maple sirup, maple sugar, oats, rice, rye, sorghum molasses, sweet potatoes, and wool.

TABLE II.—*Dairy statistics by States.*

[From the Eleventh United States Census, 1890.]

States and Territories.	Milk cows.	Milk all produced on farms.	Butter made on farms.	Butter made at creameries.	Cheese made on farms.	Cheese made at factories.
	<i>Number.</i>	<i>Gallons.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
The United States...	16,511,950	5,209,125,567	1,024,223,468	181,284,916	18,726,818	238,035,065
North Atlantic Division...	3,351,061	1,435,739,255	246,788,544	48,245,172	6,693,671	132,545,023
Maine.....	157,278	57,969,791	15,593,315	1,406,041	696,052	755,761
New Hampshire.....	109,423	42,633,268	7,942,840	1,919,590	341,235	103,399
Vermont.....	231,419	90,712,230	23,314,063	5,085,377	609,586	5,582,327
Massachusetts.....	172,046	82,571,924	8,358,703	2,051,597	122,900	262,633
Rhode Island.....	23,943	10,610,547	965,456	233,783	24,031	300,000
Connecticut.....	127,892	54,413,822	7,196,095	3,173,164	112,568	195,955
New York.....	1,440,230	668,917,240	98,241,813	14,485,702	4,324,028	119,762,496
New Jersey.....	161,576	64,003,953	8,367,218	499,531	23,613	563,628
Pennsylvania.....	927,254	368,906,480	76,809,041	19,390,387	439,060	5,018,637
South Atlantic Division...	1,369,466	331,728,677	78,270,311	2,143,028	271,291	144,000
Delaware.....	32,574	10,699,362	2,026,498	466,761	359	.....
Maryland.....	142,198	46,601,218	9,999,602	847,277	9,573	14,000
District of Columbia.....	863	459,978	13,769	.....	.....	.....
Virginia.....	273,634	78,143,459	17,949,960	811,899	109,187	109,000
West Virginia.....	188,492	59,449,066	14,063,627	18,000	74,572	21,000
North Carolina.....	223,416	55,250,665	13,129,374	.....	60,760	.....
South Carolina.....	107,184	23,833,631	5,757,557	.....	2,476	.....
Georgia.....	287,717	52,234,508	14,483,323	.....	12,833	.....
Florida.....	114,388	5,056,790	867,195	.....	1,731	.....
North Central Division...	8,240,999	2,719,414,765	520,625,636	129,925,952	6,669,421	103,556,440
Ohio.....	794,833	326,925,396	74,990,307	6,532,485	1,068,083	21,185,971
Indiana.....	579,287	200,510,797	48,477,766	1,677,088	360,948	830,552
Illinois.....	1,087,886	367,209,464	57,121,486	25,553,422	343,456	10,005,477
Michigan.....	497,611	224,537,488	50,197,481	2,145,731	328,682	5,041,778
Wisconsin.....	792,620	303,701,134	46,295,623	14,059,876	906,266	53,708,593
Minnesota.....	593,908	182,968,973	34,766,469	13,911,095	676,642	3,615,528
Iowa.....	1,498,418	486,961,411	72,893,079	53,143,140	1,038,358	4,705,376
Missouri.....	851,076	193,931,103	43,108,521	1,529,647	288,620	1,384,397
North Dakota.....	88,289	26,566,112	5,712,566	446,296	131,374	49,000
South Dakota.....	210,240	59,666,525	13,127,244	532,513	303,951	250,812
Nebraska.....	505,045	144,768,263	27,818,078	6,076,783	463,831	804,618
Kansas.....	741,786	201,608,099	46,117,076	4,317,876	759,210	1,974,136
South Central Division...	2,829,657	519,693,663	135,192,272	110,679	318,367	31,300
Kentucky.....	364,516	118,497,289	29,038,406	.....	64,822	.....
Tennessee.....	345,311	107,657,116	28,314,387	65,990	69,919	31,300
Alabama.....	292,088	55,508,687	14,548,435	.....	6,131	.....
Mississippi.....	310,159	50,803,371	12,988,637	.....	4,898	.....
Louisiana.....	167,223	12,881,927	2,089,774	.....	3,939	.....
Texas.....	1,093,439	118,475,320	32,100,560	44,689	145,730	.....
Oklahoma.....	16,756	1,544,280	387,920	.....	1,600	.....
Arkansas.....	330,165	54,325,673	15,724,144	.....	21,328	.....
Western Division.....	720,767	202,549,207	43,346,105	820,185	4,774,068	1,745,802
Montana.....	24,143	6,038,096	1,062,185	.....	11,512	.....
Wyoming.....	11,684	3,064,588	428,269	.....	15,196	.....
Colorado.....	76,948	19,680,791	3,282,086	339,000	87,183	44,500
New Mexico.....	18,507	717,155	86,042	.....	18,931	.....
Arizona.....	4,874	709,225	115,203	.....	10,855	.....
Utah.....	45,982	8,614,694	1,750,354	55,800	163,539	13,200
Nevada.....	9,273	2,532,052	489,657	.....	51,207	.....
Idaho.....	27,278	5,085,863	1,078,103	13,650	207,213	116,640
Washington.....	70,721	19,873,281	3,482,225	1,500	71,281	249,700
Oregon.....	114,156	25,042,276	4,786,277	138,468	205,576	230,540
California.....	317,201	111,191,186	26,776,704	271,767	3,871,575	1,091,222

DIAGRAM B.—Total cheese and butter production of the United States in 1890, by States, arranged according to rank.

[The number in the center of each subdivision denotes the percentage of the total product represented which was made in that State.]

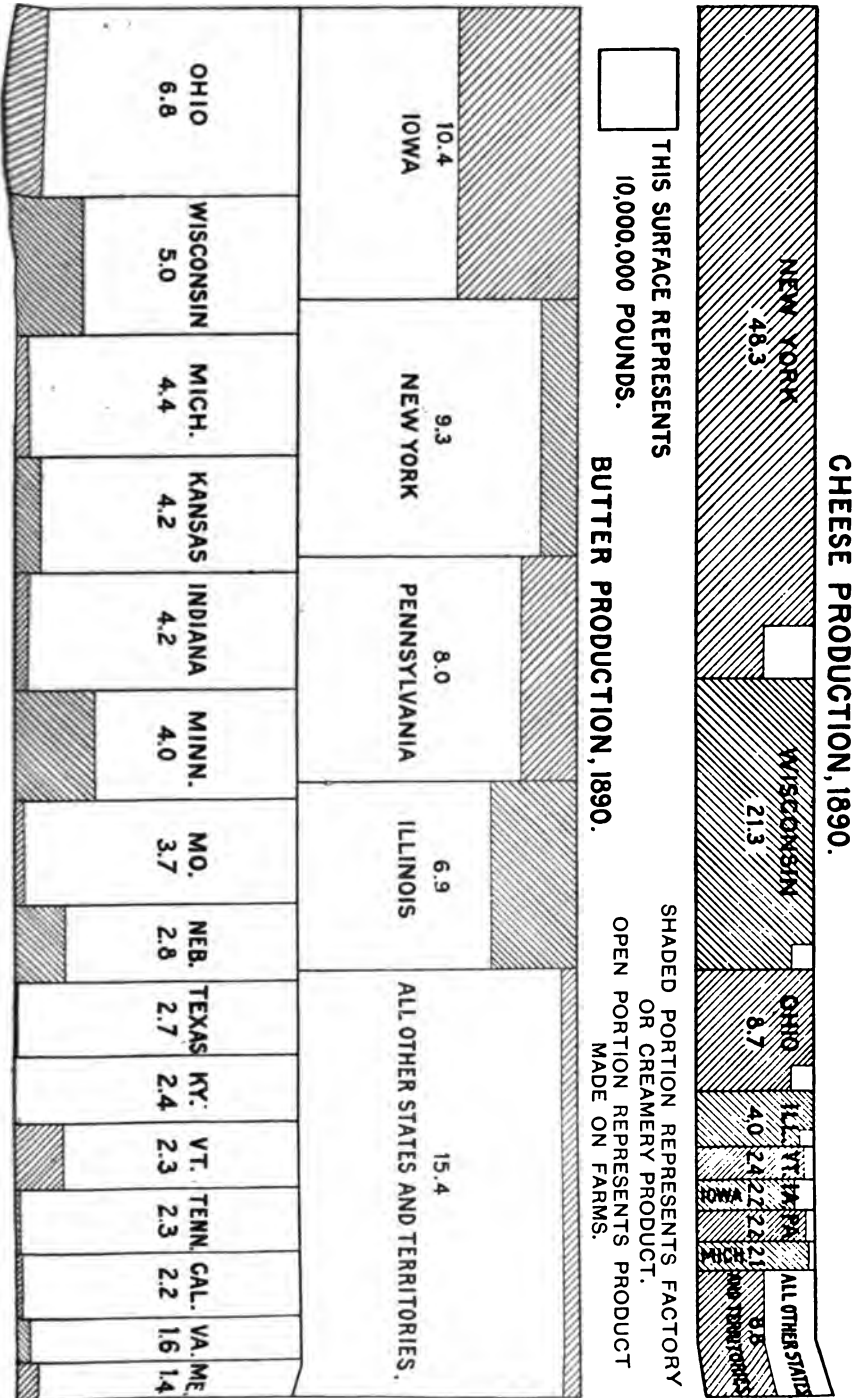


TABLE III.—*Progress of dairying in the United States.*

[United States Census statistics for half a century.]

States and Territories.	Year of census.	Milk cows.		Milk, product reported.	Butter, total made.	Cheese, total made.	Creameries and cheese factories.	Milk, average yield per cow.
		Total number.	Per 1,000 persons.					
				<i>Gallons.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Number.</i>	<i>Gallons.</i>
United States...	1890	16,511,950	264	5,209,125,567	1,205,608,384	256,761,883	4,712	315.4
	1880	12,443,120	248	* 530,129,755	806,672,071	243,157,850	3,933	232.5
	1870	8,935,332	232	† 235,500,599	514,092,683	162,927,382	a 1,313	205.9
	1860	8,585,735	273	Not given.	459,681,372	103,663,927	a 5	174.7
	1850	6,385,094	275	Not given.	313,345,306	105,535,893	a 8	106.5
North Atlantic Division	1890	3,351,061	193	1,435,739,255	295,033,716	139,238,694	1,971	428.4
	1880	3,190,745	220	* 345,749,869	277,008,072	150,902,229	1,975	.....
	1870	2,833,022	230	† 186,605,146	225,910,518	35,144,853	a 912	.....
	1860	2,615,929	.....	.....	223,950,757	72,860,013	.....	.....
	1850	2,188,563	.....	.....	173,055,728	79,731,981	.....	.....
Maine	1890	157,278	238	57,969,791	16,999,356	1,451,813	42	368.5
	1880	150,845	232	* 3,720,783	14,109,966	1,945,085	41	314.2
	1870	139,259	222	† 1,374,091	11,636,482	1,152,590	0	270.2
	1860	147,314	235	.....	11,687,781	1,799,862	.....	252.3
	1850	133,556	229	.....	9,243,811	2,434,454	.....	228.9
New Hampshire	1890	109,423	290	42,633,268	9,862,430	444,622	23	390.6
	1880	90,564	261	* 5,739,128	7,346,340	807,076	2	313.8
	1870	90,583	285	† 2,352,884	5,965,080	872,368	a 2	284.5
	1860	94,880	291	.....	6,956,764	2,232,092	.....	247.4
	1850	94,277	265	.....	6,977,056	3,196,563	.....	261.6
Vermont	1890	231,419	697	90,712,230	28,399,440	6,191,913	124	892.9
	1880	217,033	654	* 6,526,550	25,252,663	6,129,879	85	367.0
	1870	180,285	545	† 3,835,840	17,844,396	7,814,879	a 28	349.5
	1860	174,697	534	.....	15,900,359	8,215,030	.....	338
	1850	146,128	465	.....	12,137,980	8,730,834	.....	318.8
Massachusetts	1890	172,046	77	82,571,924	10,410,300	885,583	37	479.9
	1880	150,435	84	* 29,662,953	9,799,804	2,201,393	22	396.2
	1870	114,771	79	† 15,284,057	6,559,181	4,131,359	a 23	327.4
	1860	144,492	117	.....	8,297,936	5,294,090	.....	215
	1850	130,090	131	.....	7,088,142	.....	.....	249.7
Rhode Island	1890	23,943	69	10,610,547	1,199,239	324,631	4	443.1
	1880	21,460	78	* 3,831,706	1,007,103	67,171	0	323
	1870	18,806	87	† 1,944,044	841,199	81,976	0	268.6
	1860	19,700	113	.....	1,021,767	181,511	.....	166.2
	1850	18,698	126	.....	965,670	316,506	.....	179.5
Connecticut	1890	127,892	171	54,413,822	10,369,259	308,521	50	425.4
	1880	116,319	187	* 12,289,803	8,418,906	1,051,677	16	325.4
	1870	98,889	184	† 6,253,259	6,716,007	2,262,894	a 7	290.9
	1860	98,877	215	.....	7,620,912	3,898,411	.....	277.2
	1850	85,461	230	.....	6,498,119	5,363,277	.....	301.3
New York	1890	1,440,230	240	663,917,240	112,727,515	124,080,524	1,337	460.9
	1880	1,437,855	283	* 231,905,533	120,878,201	129,163,714	1,652	401.6
	1870	1,350,061	308	† 135,775,919	107,147,526	100,776,012	a 818	356.2
	1860	1,123,634	290	.....	103,097,280	48,548,289	.....	325.7
	1850	931,324	301	.....	79,766,094	49,741,413	.....	319.3
New Jersey	1890	161,576	112	64,003,953	8,866,749	587,241	16	366.1
	1880	152,078	134	* 15,472,793	9,872,237	669,736	11	299.9
	1870	133,331	147	† 5,373,323	8,266,023	478,336	a 8	226.6
	1860	138,818	207	.....	10,714,447	182,172	.....	233.1
	1850	118,736	242	.....	9,487,210	365,756	.....	243.2
Pennsylvania	1890	927,254	176	368,906,480	96,199,428	5,457,897	838	397.8
	1880	854,156	199	* 30,540,540	80,322,852	8,966,737	146	322.8
	1870	706,437	201	† 14,411,729	60,834,644	2,792,676	a 27	280.6
	1860	673,547	232	.....	58,653,511	2,508,556	.....	205.6
	1850	530,224	229	.....	39,878,418	2,505,034	.....	231.1
South Atlantic Division	1890	1,369,406	155	331,728,677	80,414,839	415,291	50	242.2
	1880	1,280,761	169	* 3,446,511	48,703,330	640,065	31	.....
	1870	1,001,094	171	† 3,187,589	28,575,306	190,890	a 5	.....
	1860	1,238,633	.....	.....	33,941,403	369,302	.....	.....
	1850	1,246,678	.....	.....	28,105,896	610,836	.....	.....
Delaware	1890	32,574	194	10,699,362	2,493,259	359	6	322.4
	1880	27,281	186	* 1,132,434	1,902,075	1,712	3	247.9
	1870	24,082	192	† 758,603	1,171,963	315	0	177.5
	1860	22,595	202	.....	1,430,502	6,579	.....	190.3
	1850	19,248	209	.....	1,055,308	3,187	.....	164.7
Maryland	1890	142,198	136	46,601,218	10,846,879	23,573	24	327.7
	1880	122,907	131	* 4,722,944	7,715,196	79,416	14	321.3
	1870	94,794	121	† 1,520,941	5,014,729	6,732	0	174.8
	1860	99,463	145	.....	5,265,295	8,342	.....	158.9
	1850	86,856	149	.....	3,806,100	3,975	.....	131.5

* "Milk sold or sent to butter and cheese factories, gallons," census, 1880.

† "Milk sold from farms, gallons," census, 1870.

a Cheese factories only. b See Note c of Table I.

TABLE III.—Progress of dairying in the United States—Continued.

(United States Census statistics for half a century.)

States and Territories.	Year of census.	Milk cows.		Milk, product reported.	Butter, total made.	Cheese, total made.	Creameries and cheese factories.	Milk, average yield per cow.
		Total number.	Per 1,000 persons.					
South Atlantic Division—Continued.								
Dist. Columbia	1880	963	4	Gallons. 459,978	Pounds. 13,769		4	532.9
	1880	1,292	7	* 496,789	88,520	155,460	1	433.1
	1870	657	5	† 126,077	4,495		0	212.1
	1860	639	9		18,835			88.4
	1850	813	16		14,872	1,500		57
Virginia	1880	273,634	165	78,143,459	18,761,856	218,187	13	285.5
	1880	243,061	161	* 1,224,409	11,500,023	111,535	4	147
	1870	188,471	154	† 206,812	6,979,269	84,243	a 2	113
	1860	330,713	207		13,464,722	286,852		123.1
	1850	317,619	223		11,089,359	436,292		106.3
West Virginia	1880	188,492	247	50,449,066	14,081,627	95,372	3	315.3
	1880	156,956	254	* 750,279	9,309,517	196,987	7	183.5
	1870	104,434	236	† 144,895	5,044,475	32,429	0	146.7
North Carolina	1880	223,416	138	55,250,665	13,129,374	60,760	0	247.2
	1880	232,133	166	* 446,798	7,213,507	57,380	2	95.4
	1870	196,731	184	† 117,145	4,297,834	123,985	a 3	66.1
South Carolina	1880	228,623	230		4,735,495	51,119		62.4
	1850	221,790	255		4,146,290	95,921		56.6
	1880	107,184	93	23,833,631	5,737,557	2,476	0	222.3
Georgia	1880	139,881	140	* 257,180	3,196,851	16,018	0	70.5
	1870	98,693	140	† 241,815	1,461,980	169	0	46.9
	1860	163,938	233		3,177,934	1,543		58.2
Florida	1850	193,244	289		2,981,850	4,970		46.3
	1880	287,717	157	52,234,508	14,483,323	12,833	0	181.5
	1880	315,073	204	374,645	7,424,485	19,151	0	72
Ohio	1870	231,310	195	† 109,139	4,499,572	4,292	0	58.9
	1860	299,668	284		5,439,765	15,587		54.5
	1850	334,223	369		4,640,559	46,976	0	41.8
Indiana	1880	113,388	290	5,056,790	867,195	1,731	0	44.5
	1880	42,174	157	* 40,967	352,156	2,406	0	26.2
	1870	61,922	329	† 3,002	100,989	25	0	4.9
North Central Division	1860	92,974	664		408,855	5,280		13.3
	1850	72,876	838		371,498	18,015		15.6
Ohio	1880	8,240,999	369	2,719,414,765	650,551,588	110,225,861	2,617	317.8
	1880	5,402,081	311	153,044,519	383,455,099	86,532,570	1,648	
	1870	3,294,007	254	† 38,853,454	214,400,425	14,178,005	398	
Indiana	1880	2,556,536			153,071,558	28,238,411		
	1850	1,564,219			80,563,732	24,547,518		
	1880	794,833	216	326,925,396	81,522,792	22,254,054	361	411.3
Illinois	1880	767,043	240	46,801,537	69,722,506	32,531,683	452	328.8
	1870	634,390	246	† 22,275,344	50,266,372	24,153,876	195	279
	1860	676,585	289		48,543,162	21,618,893		252.5
Michigan	1880	544,499	275		34,449,379	20,819,542		234.4
	1880	579,287	264	200,510,797	50,154,854	1,191,500	55	346.1
	1880	494,944	250	* 6,723,840	37,712,316	1,676,825	49	241
Wisconsin	1870	393,736	234	† 936,983	22,915,385	391,487	17	177.8
	1860	363,553	269		18,306,051	605,795		153
	1850	284,554	288		12,881,535	624,561		138.4
Minnesota	1880	1,087,886	284	367,269,464	82,674,908	10,318,933	266	337.5
	1880	865,913	281	45,419,719	60,208,972	21,253,194	285	239.7
	1870	640,321	252	† 9,258,545	36,083,105	5,734,004	69	186.5
Iowa	1880	522,634	305		28,052,551	1,848,557		165.2
	1850	294,671	346		12,526,543	1,278,225		132.6
	1880	497,611	238	224,537,488	52,343,212	5,370,460	101	451.2
Nebraska	1880	384,578	235	* 7,898,273	38,865,106	3,953,585	74	324.7
	1870	250,859	127	† 2,277,122	24,400,185	2,301,801	30	304
	1860	179,543	240		15,503,872	1,641,897		269.7
Kansas	1850	99,676	250		7,065,878	1,011,492		224.5
	1880	792,620	470	303,701,134	60,355,499	54,614,861	966	383.1
	1880	478,374	364	* 25,156,977	33,842,336	19,535,324	414	267.3
Missouri	1870	308,377	292	† 2,059,105	22,473,036	3,288,581	54	231.3
	1860	293,001	262		13,611,328	1,104,300		207.5
	1850	64,339	211		3,633,750	400,283		176.7
Arkansas	1880	593,908	456	182,968,973	48,677,564	4,292,170	115	308.1
	1880	275,545	353	* 1,504,497	19,244,835	985,329	27	216.3
	1870	121,467	276	† 208,130	9,522,010	271,477	2	239.1
Louisiana	1860	40,344	235		2,957,673	199,314		225.7
	1850	607	101		1,100			5.4
	1880	1,498,418	784	486,961,411	126,036,219	5,743,934	500	324.9
Texas	1880	854,187	526	* 15,965,612	61,665,071	3,852,801	244	215

* Milk sold or sent to butter and cheese factories, gallons, census, 1880.

† Milk sold from farms, gallons, census, 1870.

a Cheese factories only.

TABLE III.—*Progress of dairying in the United States—Continued.*

[United States Census statistics for half a century.]

States and Territories.	Year of census.	Milch cows.		Milk, product reported.	Butter, total made.	Cheese, total made.	Creameries and cheese factories.	Milk, average yield per cow.
		Total number.	Per 1,000 persons.					
North Central Division—Continued.								
Iowa (Cont'd).....	1870	369,811	310	Gallons. † 688,800	Pounds. 27,512,179	Pounds. 1,344,647	Number 14	Gallons. 228.5
	1880	189,802	281		11,953,666	918,635		194.6
	1850	45,704	238		2,171,188	209,840		147.9
Missouri.....	1880	851,076	318	193,931,103	44,638,168	1,673,017	68	227.9
	1880	661,405	305	* 3,173,017	28,712,988	873,549	30	134.9
	1870	398,515	232	† 857,704	14,455,825	213,865	1	111.6
	1860	345,243	202		12,704,837	259,633		111.3
	1850	230,169	337		7,834,359	203,572		103.1
North Dakota.....	1890	88,289	482	26,566,112	6,158,862	180,374	10	309.8
South Dakota.....	1890	210,240	639	59,666,525	13,659,757	554,763	16	283.8
Dakota Ter.....	1880	40,572	301	* 415,119	2,006,755	40,137	4	159.3
	1870	4,151	297		209,735	1,850	0	152.1
	1860	286	57		2,170			22.8
Nebraska.....	1890	505,045	477	144,768,263	33,894,861	1,268,449	58	286.6
	1880	101,187	357	* 625,783	9,790,970	554,772	21	186.6
	1870	28,940	235	† 95,059	1,539,535	78,542	5	164.7
	1860	6,995	241		342,541	12,342		149
Kansas.....	1890	741,786	520	201,008,099	50,434,952	2,733,346	101	271.7
	1880	418,333	420	* 1,360,235	21,683,244	1,275,371	48	160.
	1870	123,440	339	† 196,662	5,022,758	241,607	1	125.8
	1860	28,550	267		1,093,497	29,045		116.1
South Central Division								
	1890	2,829,657	258	519,693,663	135,302,951	349,667	22	183.6
	1880	2,147,440	241	* 6,084,788	74,208,771	276,923	10	
	1870	1,494,434	232	† 2,811,323	34,062,404	311,498	4	
	1860	1,859,117			44,132,365	644,416		
	1850	1,356,491			31,324,361	571,582		
Kentucky.....	1890	364,516	196	118,497,289	29,038,406	64,822	15	325
	1880	301,882	181	* 2,513,209	18,261,064	58,468	8	189.5
	1870	247,615	187	† 1,345,779	11,874,978	361,219	4	149.9
	1860	269,215	233		11,716,609	190,400		131.4
	1850	247,475	252		9,947,523	213,954		121.6
Tennessee.....	1890	345,311	195	107,657,116	28,380,877	101,219	4	311.6
	1880	303,900	197	* 1,006,795	17,889,960	107,740	2	180.3
	1870	243,197	193	† 415,786	9,571,069	142,240	0	120.5
	1860	249,514	225		10,017,787	135,575		121.1
	1850	250,456	250		8,139,585	177,681		98.3
Alabama.....	1890	292,088	193	55,508,687	14,548,435	6,131	0	190
	1880	271,443	215	* 267,387	7,997,719	14,091	0	89.4
	1870	170,640	171	† 104,657	3,213,753	2,733		57.1
	1860	230,537	230		6,028,478	15,923		78.5
	1850	227,791	295		4,008,811	31,412		53
Mississippi.....	1890	310,159	240	50,803,371	12,988,637	4,898	0	163.7
	1880	268,178	237	* 427,492	7,454,657	4,239	0	85
	1870	173,899	210	† 117,052	2,613,521	3,099	0	45.2
	1860	207,646	263		5,006,610	4,427		72.4
	1850	214,231	353		4,346,234	21,191		61
Louisiana.....	1890	167,223	149	12,881,927	2,089,774	3,939	0	77
	1880	146,454	156	* 256,241	916,089	7,618	0	20.6
	1870	102,076	140	† 833,928	322,405	11,747	0	17.8
	1860	129,662	183		1,444,742	6,153		33.5
	1850	105,576	204		683,069	1,967		19.4
Texas.....	1890	1,003,439	449	118,475,320	32,145,249	145,780	3	118
	1880	606,176	381	* 1,296,806	13,899,820	58,466	0	71
	1870	428,048	523	† 62,771	3,712,747	34,342	0	26.3
	1860	601,540	996		5,850,583	275,128		20.7
	1850	217,811	1,023		2,344,900	95,299		32.8
Oklahoma.....	1890	16,756	270	1,544,280	387,920	1,600	0	92.1
Arkansas.....	1890	330,165	293	54,325,673	15,724,144	21,328	0	164.5
	1880	249,407	311	* 316,858	7,790,013	26,301	0	95.1
	1870	128,959	266	† 31,350	2,753,931	2,119		64.3
	1860	171,003	393		4,067,556	16,810		71.5
	1850	93,151	444		1,854,239	30,088		60.1
Western Division								
	1890	720,767	238	202,549,207	44,166,290	6,519,870	52	281
	1880	422,093	239	* 13,804,068	23,296,799	4,806,063	268	
	1870	312,775	316	† 4,043,087	11,144,030	3,666,907	3	
	1860	315,520			4,585,289	1,551,785		
	1850	29,203			295,589	73,976		
Montana.....	1890	24,143	183	6,038,096	1,062,185	11,512	1	250
	1880	11,308	290	* 41,165	412,738	80,070	3	116.5
	1870	12,432	592	† 105,186	408,080	27,093	1	109.3

*** Milk sold or sent to butter and cheese factories, gallons," census, 1880.

†† Milk sold from farms, gallons," census, 1870.

TABLE III.—Progress of dairying in the United States—Continued.

[United States Census statistics for half a century.]

States and Territories.	Year of census.	Milk cows.		Milk, product reported.	Butter, total made.	Cheese, total made.	Creameries and cheese factories.	Milk, average yield per cow.
		Total number.	Per 1,000 persons.					
Western Division—Continued.				Gallons.	Pounds.	Pounds.	Number	Gallons.
Wyoming.....	1890	11,634	192	3,064,588	428,269	15,196	1	262.2
	1880	3,730	178	* 75,343	105,643	2,930	0	106.1
	1870	707	79	† 4,980	1,200	.....	0	12.1
Colorado.....	1890	76,948	187	19,080,791	3,621,080	131,683	6	255.7
	1880	28,770	148	* 506,706	862,479	75,367	2	107.8
	1870	25,017	625	† 19,520	392,920	37,626	1	49.5
New Mexico....	1890	18,507	120	717,155	860,042	18,931	0	38.7
	1880	12,955	108	* 10,036	44,827	10,501	0	12.1
	1870	16,417	178	† 813	12,912	27,239	0	4.3
	1860	34,369	366	.....	13,259	37,240	.....	2.4
	1850	10,635	172	.....	111	5,848	.....	.7
Arizona.....	1890	4,874	81	709,225	115,203	10,855	0	145.5
	1880	9,156	229	* 42,618	62,217	62,217	2	27.2
	1870	938	94	† 4,800	800	14,500	0	25.7
Utah.....	1890	45,982	221	8,614,694	1,815,154	176,739	3	187.3
	1880	32,768	228	* 155,263	1,064,923	266,749	11	105.6
	1870	17,563	202	† 11,240	310,335	69,003	0	58.3
	1860	11,067	299	.....	316,046	53,331	.....	84.4
	1850	4,861	442	.....	83,309	30,998	.....	58.9
Nevada.....	1890	9,273	202	2,532,052	489,657	51,207	1	273
	1880	13,319	215	* 149,889	338,683	17,420	2	88.3
	1870	6,174	147	† 63,850	110,880	.....	0	64.2
	1860	947	135	.....	7,700	.....	.....	24.4
Idaho.....	1890	27,278	325	5,985,863	1,091,753	323,853	4	186.4
	1880	12,838	389	* 15,627	314,244	117,295	6	75.7
	1870	4,171	278	† 11,250	111,480	4,464	0	84.1
Washington....	1890	70,721	203	19,873,281	3,483,725	320,981	3	281
	1880	27,622	268	* 226,703	1,404,066	179,200	2	160.1
	1870	16,938	706	† 21,060	407,306	17,465	0	74.6
	1860	9,660	805	.....	153,092	12,146	.....	49
Oregon.....	1890	114,156	363	25,042,276	4,924,745	496,116	12	219.3
	1880	59,549	340	* 227,540	2,528,225	299,732	24	129.9
	1870	48,325	531	† 107,367	1,418,373	119,383	1	92.2
	1860	53,170	1,022	.....	1,090,157	105,379	.....	58.7
	1850	9,427	725	.....	211,464	36,980	.....	71.9
California.....	1890	317,201	263	111,191,186	27,048,471	4,962,797	21	350.5
	1880	210,678	243	* 12,353,178	16,158,749	3,720,739	216	274.2
	1870	164,093	293	† 3,693,021	7,969,744	3,395,074	0	192.4
	1860	205,407	541	.....	3,095,035	1,343,689	.....	52.8
	1850	4,280	40	.....	705	150	.....	.5

* "Milk sold or sent to butter and cheese factories, gallons," census, 1880.

† "Milk sold from farms, gallons," census, 1870.

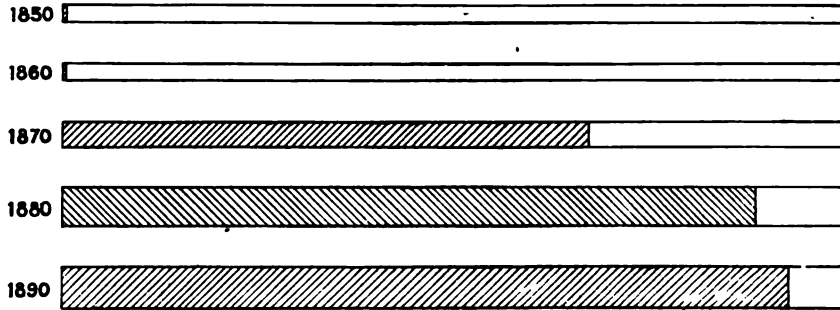
NOTE.—Table III is taken entire from census reports excepting the last column. In that the figures for 1890 are computed from the census, and those for the other years are quoted from reports of the Department of Agriculture.

The column of "average milk yield per cow" shows an increase, decade after decade, which indicates a rapid improvement in cows. But these figures are misleading, because their basis varies for different years. In the earlier censuses the milk yield was not reported. For 1850 and 1860 only the butter and cheese made on farms were given, and the average milk yield per cow estimated erroneously by reducing the reported products to an equivalent in milk and dividing by the number of cows. The cows were thus credited with only such milk as was made into butter and cheese. For 1870 and 1880 the same plan was followed, but milk sold being also reported, this was added to that manufactured on farms: the large quantity of milk consumed on farms was still omitted from the computation. For 1890 the census reported the total milk product for the first time; this being directly divided by the number of producing cows, gives the annual average yield per cow, which should be accurate. Yet even for 1890 the yield appears unreliable in some cases. In the States of Connecticut, Massachusetts (480 gallons), Michigan (451), New York (461), Ohio, and Rhode Island the yield per cow appears to be above 400 gallons per year, while other States which carry just as good cows show a much lower average, and some States are so reported as to allow less than a gallon of milk per day per cow for a milking period limited to three or four months. Liberal allowances must be made in accepting such figures, although they are the best available.

DIAGRAM C.—*Cheese and butter production—five census years.*

[Factory and creamery production are shaded.]

CHEESE.



THIS SURFACE REPRESENTS
50,000,000 POUNDS.



BUTTER.

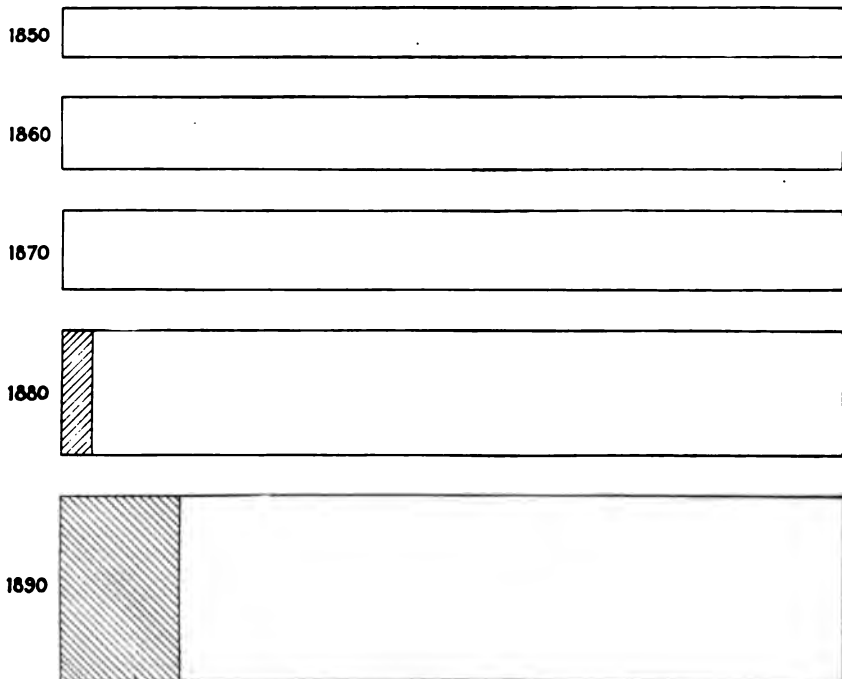


TABLE IV.—*Butter, cheese, and condensed-milk factories, including all "creameries."*

[From the census of the United States for 1890, 1880, and 1870.]

NOTE.—Urban establishments were separately reported from 20 different States in 1890, but incompletely, as shown below. None such reported in 1880.

Totals for the United States.	1890.	Urban establishments, 1890.	1880.	1870.
Number of establishments reporting	4,552	160	3,932	1,313
Capital employed, aggregate.....dollars..	16,016,573	607,590	9,604,803	3,690,075
Plant, total value.....do.....	11,639,692	449,880		
Land.....do.....	968,333	145,692		
Buildings.....do.....	5,588,257	150,149		
Machinery.....do.....	5,083,102	154,039		
Live assets.....do.....	4,376,881	157,710		
Expenses, total annual.....do.....	813,954	61,228		
Employees.....average number.....	14,389	552	7,903	4,607
Total wages paid.....dollars.....	5,116,005	274,700	1,546,495	706,566
Earnings of skilled operatives, weekly:				
Average for males above 16 years.....do.....	9.48			
Average for females above 15 years.....do.....	5.35			
Average for children.....do.....	2.75			
Hours of labor, daily average:				
May to November.....hours.....	11.09			
November to May.....do.....	10.03			
Materials used:				
Aggregate cost.....dollars.....	49,819,301	1,545,273	18,363,579	14,089,284
For butter—				
Gathered cream.....pounds.....	483,630,741			
Milk.....do.....	1,893,319,242			
Total cost.....dollars.....	29,538,827		4,644,214	
For cheese—				
Milk.....pounds.....	2,684,550,517			
Total cost.....dollars.....	16,953,992		12,692,507	14,089,284
For condensed milk—				
Milk.....pounds.....	83,617,655			
Sugar.....do.....	13,372,365			
Total cost.....dollars.....	2,792,086		1,026,858	
Fuel and rented power, cost.....do.....	534,396			
Products:				
Aggregate value.....do.....	60,635,705	2,050,338	25,815,963	16,771,665
Butter made—				
Quantity.....pounds.....	181,284,916		29,421,784	
Value.....dollars.....	36,675,411		6,535,790	
Cheese, full cream—				
Quantity.....pounds.....	184,158,174			
Value.....dollars.....	10,112,871			
Cheese, skim—				
Quantity.....pounds.....	22,467,132			
Value.....dollars.....	1,230,297			
Cheese, all other made—				
Quantity.....pounds.....	31,409,759			
Value.....dollars.....	2,459,783			
Cheese, total made—				
Quantity.....pounds.....	238,035,065		215,885,361	109,435,229
Value.....dollars.....	19,802,951		17,659,123	16,710,569
Condensed milk—				
Quantity.....pounds.....	37,926,821		13,033,267	
Value.....dollars.....	3,586,927		1,547,588	
Skim milk and all other products, value, dollars.....	570,416		73,453	61,096

NOTE.—In this table the figures in the column for 1870 relate to cheese factories, no other product being reported. The column for 1880 requires no explanation except that at this time butter factories or creameries had become numerous, although their product was but little more than one-third in value of the factory cheese produced. For 1890 there are two columns, as the "urban establishments" for making butter and cheese were dealt with by the census separately from the butter and cheese factories in general.

It should be noted that these figures are from the "number of establishments reporting." It is known that, in fact, there were a good many more creameries in operation in the country in 1889-90 than the number reported in the table. The aggregate products of factory-made butter and cheese thus shown must be considerably less than the actual output of existing factories. The census returns of total dairy products of the United States for 1889 must, therefore, be below the actual facts.

This table, although thus incomplete, shows the rapid growth of the cooperative or factory system of dairying. Farm cheese making has practically disappeared since the advent of cheese factories and

creameries, and the proportion of factory-made butter is fast increasing, although the quantity of butter made on farms is increasing also.

In 1890 the number of creameries, etc., reported by the census for New York allows one for every 36 square miles in the State. These factories thus averaged but 6 miles apart, giving the longest average drive for their patrons as about 4 miles.

Iowa reported 590 creameries in 1890, and State officials give 774 as the number for 1895. The latter gives one factory to every 72 square miles, an average of about 8 miles apart.

As to the 4,552 suburban factories reporting in 1890, it appears that these establishments averaged 4,261 pounds of milk per day as the material used at each creamery or factory. The average number of employees was $3\frac{1}{2}$ to a factory. The combined factories reporting handled about 17 per cent of all the milk (reported) produced on the farms of the United States.

In connection with this table, attention is called to the Diagrams B and C.

TABLE V.—*Number and value of milch cows in the United States, and of other farm animals, yearly, 1870 to 1895, inclusive, with a few earlier years.*

[From the annual reports of the Department of Agriculture.]

Year.	Milch cows.		Oxen and other cattle.		Horses.		Total value of farm animals.
	Number.	Value.	Number.	Value.	Number.	Value.	
1840	4,837,043	\$72,555,000	10,171,586	.....	4,335,669	.....	.....
1850	6,385,094	127,840,880	11,393,813	.....	4,336,719	.....	\$544,186,516
1860	8,585,735	264,643,375	17,034,284	.....	6,249,174	.....	1,089,329,915
1870	10,095,060	394,940,745	15,388,500	\$346,926,440	8,248,800	\$671,319,461	1,822,327,377
1871	10,023,000	374,179,693	16,212,200	369,940,056	8,702,000	683,257,587	1,810,142,711
1872	10,303,500	329,408,983	16,389,800	321,562,693	8,990,900	659,707,916	1,659,211,933
1873	10,575,900	314,358,931	16,413,800	329,298,755	9,222,470	684,463,957	1,684,431,693
1874	10,705,300	299,609,209	16,218,100	310,649,803	9,333,800	666,927,466	1,619,944,472
1875	10,906,800	311,089,824	16,313,400	304,858,859	9,504,200	646,370,939	1,618,012,221
1876	11,085,400	320,346,728	16,785,300	319,623,509	9,735,300	632,446,985	1,647,719,138
1877	11,260,800	307,743,211	17,956,100	307,105,386	10,155,400	610,206,631	1,576,506,093
1878	11,390,100	298,499,866	19,223,300	329,541,703	10,329,700	600,813,681	1,574,620,783
1879	11,826,400	256,953,928	21,408,100	329,543,327	10,938,700	573,254,808	1,445,423,062
1880	12,627,000	279,899,420	21,231,000	341,791,154	11,201,800	613,296,611	1,576,917,556
1881	12,368,653	296,277,090	20,937,702	362,861,509	11,429,626	607,954,325	1,721,795,252
1882	12,611,632	326,489,310	23,280,238	463,069,499	10,521,554	615,824,914	1,906,468,250
1883	13,125,685	396,575,405	28,046,077	611,549,109	10,838,111	765,041,308	2,338,215,268
1884	13,501,206	423,486,649	29,046,101	683,229,054	11,169,683	833,734,400	2,467,868,924
1885	13,904,722	412,903,093	29,866,573	694,382,913	11,564,572	852,282,947	2,456,428,383
1886	14,235,388	389,985,523	31,275,242	661,956,274	12,077,657	860,823,208	2,365,159,862
1887	14,522,083	378,789,589	33,511,750	663,137,926	12,406,744	901,685,755	2,400,586,938
1888	14,856,414	366,252,173	34,378,363	611,750,520	13,172,938	946,096,154	2,409,043,418
1889	15,298,625	366,226,376	35,032,417	597,236,812	13,663,294	982,194,827	2,507,050,058
1890	15,952,883	353,152,133	36,849,024	560,625,137	14,213,837	978,516,562	2,418,766,028
1891	16,019,591	346,397,900	36,875,648	544,127,908	14,056,750	941,823,222	2,329,787,770
1892	16,416,351	351,378,132	37,651,239	570,749,155	15,498,140	1,007,593,636	2,461,755,698
1893	16,424,087	357,299,785	35,954,196	547,882,204	16,206,802	992,225,185	2,483,506,681
1894	15,487,400	358,998,661	36,608,168	536,789,747	16,081,139	769,224,799	2,170,816,754
1895	16,504,629	362,601,729	34,364,216	482,999,129	15,893,318	576,730,580	1,817,802,110

NOTE.—Some of the figures above agree exactly with those of the census for the corresponding year. In other cases, for census years, the numbers of animals as reported by the Department differ somewhat from those of the census.

TABLE VI.—Cattle statistics (additional) by States.

[From the Eleventh United States Census.]

States and Territories.	Neat cattle on farms, June 1, 1890.				Percentage according to quality or breeding.		
	Total oxen, cows, and other cattle.	Quality or breeding.			Pure-bred.	Grades one-half or over.	Common or native.
		Pure-bred recorded.	Grade one-half blood or higher.	Common native or low-grade.			
The United States.....	51,363,572	506,060	8,257,989	42,599,523	.99	16.08	82.93
North Atlantic Division.....	5,461,724	96,661	896,528	4,468,535	1.77	16.41	81.82
Maine.....	299,110	5,506	79,542	214,062	1.84	26.59	71.57
New Hampshire.....	222,888	3,542	42,679	176,667	1.59	19.15	79.26
Vermont.....	395,288	6,306	90,929	298,053	1.60	23	75.40
Massachusetts.....	256,128	8,473	65,655	182,000	3.31	25.63	71.06
Rhode Island.....	34,777	1,248	9,697	23,832	3.59	27.88	68.53
Connecticut.....	203,661	7,424	43,914	152,323	3.65	21.56	74.79
New York.....	2,131,392	32,053	327,972	1,771,367	1.50	15.39	83.11
New Jersey.....	212,062	6,480	36,843	168,739	3.06	17.37	79.57
Pennsylvania.....	1,706,418	25,629	199,297	1,481,492	1.50	11.68	86.82
South Atlantic Division.....	3,890,107	28,293	288,420	3,573,394	.73	7.41	91.86
Delaware.....	51,844	1,018	9,651	41,175	1.96	18.62	79.42
Maryland.....	267,189	6,225	47,442	213,522	2.33	17.76	79.91
District of Columbia.....	988	50	233	606	5.97	23.58	70.45
Virginia.....	747,334	7,291	110,946	629,097	.97	14.85	84.18
West Virginia.....	566,066	3,042	41,971	521,053	.54	7.41	92.05
North Carolina.....	630,903	3,461	31,474	595,968	.55	4.99	94.46
South Carolina.....	268,293	2,053	12,544	253,696	.78	4.68	94.56
Georgia.....	873,026	3,931	28,148	841,847	.45	3.22	96.33
Florida.....	483,564	1,213	6,011	476,340	.25	1.24	98.51
North Central Division.....	24,572,400	297,303	5,457,320	18,817,777	1.21	22.21	76.58
Ohio.....	1,783,387	36,465	433,849	1,293,073	2.07	24.60	73.33
Indiana.....	1,511,908	23,538	294,954	1,193,416	1.56	19.51	78.93
Illinois.....	3,063,119	42,872	752,556	2,267,691	1.40	24.57	74.03
Michigan.....	1,046,771	17,468	230,310	798,993	1.67	22	76.33
Wisconsin.....	1,647,947	13,866	205,021	1,429,060	.84	12.44	86.72
Minnesota.....	1,373,579	10,825	134,397	1,228,357	.79	9.78	89.43
Iowa.....	4,895,550	60,295	1,463,856	3,371,399	1.23	29.90	68.87
Missouri.....	2,969,716	38,443	696,046	2,235,227	1.29	23.44	75.27
North Dakota.....	281,874	1,996	33,774	246,104	.71	11.98	87.31
South Dakota.....	687,919	4,527	74,468	608,924	.66	10.82	88.52
Nebraska.....	2,142,597	17,593	392,326	1,732,678	.82	18.31	80.87
Kansas.....	3,188,033	29,415	745,763	2,412,855	.92	23.39	75.69
South Central Division.....	11,724,483	54,260	793,609	10,876,614	.46	6.77	92.77
Kentucky.....	1,066,091	16,172	157,503	892,416	1.52	14.77	83.71
Tennessee.....	965,339	9,844	112,443	843,052	1.02	11.65	87.33
Alabama.....	875,976	2,767	22,519	850,690	.32	2.57	97.11
Mississippi.....	914,778	3,217	23,595	887,966	.35	2.58	97.07
Louisiana.....	581,103	1,436	10,050	569,617	.25	1.73	98.02
Texas.....	6,201,552	17,971	430,334	5,753,247	.29	6.94	92.77
Oklahoma.....	126,955	384	13,876	112,695	.30	10.93	88.77
Arkansas.....	992,689	2,460	23,289	966,931	.25	2.35	97.40
Western Division.....	5,714,858	29,543	822,112	4,863,203	.52	14.39	85.09
Montana.....	691,898	3,574	69,387	618,937	.52	10.03	89.45
Wyoming.....	685,969	1,918	59,497	624,554	.28	8.67	91.05
Colorado.....	717,861	5,524	240,340	471,997	.77	33.48	65.75
New Mexico.....	577,511	559	89,408	487,544	.10	15.48	84.42
Arizona.....	268,122	223	14,813	253,086	.08	5.53	94.39
Utah.....	200,266	2,501	26,560	171,205	1.25	13.26	85.49
Nevada.....	210,900	807	19,621	190,472	.38	9.30	90.32
Idaho.....	219,431	1,285	10,226	207,920	.59	4.66	94.75
Washington.....	255,134	2,129	20,809	232,196	.83	8.16	91.01
Oregon.....	520,648	3,687	39,965	476,996	.71	7.08	91.61
California.....	1,367,118	7,336	231,486	1,128,296	.54	16.93	82.53

DIAGRAM D.—Number of cows in each State and Territory according to the Eleventh Census.

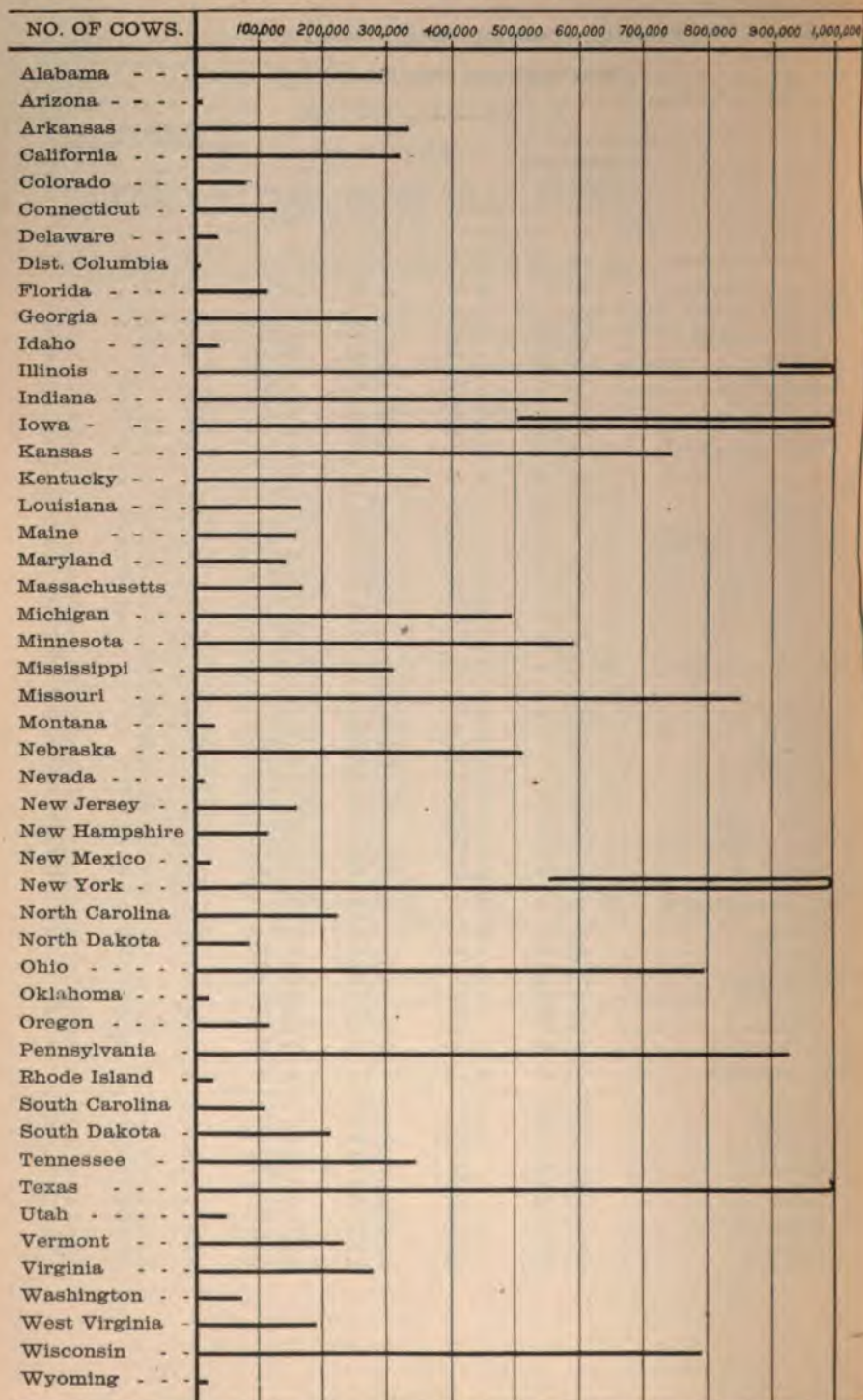


TABLE VII.—Farm statistics by States.

[From the Eleventh United States Census, 1890.]

States and Territories.	Popula- tion.	Persons "in agri- culture."	Farms.	Average size of farms.	Milch cows.	All other neat cattle.
				<i>Acres.</i>		
The United States.....	62,622,250	8,477,691	4,564,641	137	16,511,950	84,551,622
North Atlantic Division.....	17,401,545	1,080,030	658,569	95	3,351,061	2,110,663
Maine.....	651,096	78,517	62,013	109	157,278	141,832
New Hampshire.....	376,580	41,285	29,151	119	109,423	118,465
Vermont.....	332,422	53,505	32,578	135	231,419	163,869
Massachusetts.....	2,338,943	69,116	34,374	87	172,046	94,032
Rhode Island.....	345,506	11,576	5,500	85	23,948	10,534
Connecticut.....	746,258	45,243	26,350	86	127,802	75,769
New York.....	5,997,853	396,505	226,223	97	1,440,230	691,162
New Jersey.....	1,444,933	68,040	30,628	86	161,576	50,486
Pennsylvania.....	5,258,014	316,243	211,557	87	927,254	779,164
South Atlantic Division.....	8,867,920	1,641,959	749,600	134	1,369,466	2,520,641
Delaware.....	166,493	18,099	9,381	113	32,574	19,270
Maryland.....	1,042,390	90,563	40,798	121	142,198	124,991
District of Columbia.....	230,892	1,706	382	31	863	125
Virginia.....	1,655,980	257,372	127,600	150	273,634	473,700
West Virginia.....	762,794	118,623	72,773	142	188,492	377,574
North Carolina.....	1,617,947	364,956	178,359	127	223,416	407,487
South Carolina.....	1,151,149	322,887	115,008	115	107,184	161,109
Georgia.....	1,837,353	404,965	171,071	147	287,717	596,209
Florida.....	391,422	62,759	34,228	107	113,388	370,176
North Central Division.....	22,362,279	3,086,618	1,923,822	133	8,240,999	16,331,401
Ohio.....	3,672,316	398,877	251,430	93	794,833	968,554
Indiana.....	2,192,404	320,435	198,167	103	579,287	932,621
Illinois.....	3,826,851	430,795	240,681	127	1,087,886	1,975,233
Michigan.....	2,093,889	274,000	172,344	86	497,611	549,180
Wisconsin.....	1,686,880	231,311	146,409	115	792,620	855,327
Minnesota.....	1,301,826	188,405	116,851	100	563,908	779,671
Iowa.....	1,611,896	322,664	201,903	151	1,496,418	3,397,132
Missouri.....	2,679,184	387,535	238,043	129	851,076	2,116,440
North Dakota.....	182,719	43,843	27,611	277	88,289	193,585
South Dakota.....	328,808	68,154	50,158	227	210,240	477,679
Nebraska.....	1,058,910	170,058	113,608	190	505,045	1,637,552
Kansas.....	1,427,096	250,541	166,617	181	741,786	2,446,247
South Central Division.....	10,972,893	2,306,883	1,086,772	144	2,829,657	8,894,826
Kentucky.....	1,458,635	318,624	179,264	119	364,516	701,575
Tennessee.....	1,767,518	328,750	174,412	116	345,311	620,028
Alabama.....	1,513,017	369,498	157,772	126	292,088	583,888
Mississippi.....	1,289,600	358,094	144,318	122	310,150	604,619
Louisiana.....	1,118,587	236,138	69,294	138	167,223	413,880
Texas.....	2,235,523	428,087	228,126	225	1,003,439	5,198,113
Oklahoma.....	61,834	13,889	8,826	182	16,756	110,199
Arkansas.....	1,128,179	253,793	124,760	119	330,165	662,534
Western Division.....	8,927,613	337,328	145,878	324	720,767	4,994,091
Montana.....	132,159	13,635	5,603	351	24,143	667,755
Wyoming.....	60,705	7,894	3,125	586	11,684	674,285
Colorado.....	412,184	36,730	16,389	281	76,948	640,913
New Mexico.....	153,593	23,171	4,458	177	18,507	556,004
Arizona.....	59,620	6,531	1,426	910	4,874	263,248
Utah.....	207,905	19,761	10,517	126	45,982	154,284
Nevada.....	45,761	5,126	1,277	1,301	9,273	201,627
Idaho.....	84,385	13,210	6,603	197	27,278	192,153
Washington.....	349,390	37,547	18,056	231	70,721	184,413
Oregon.....	313,767	44,521	25,530	271	114,156	406,492
California.....	1,208,130	129,202	52,894	405	317,201	1,049,917

COWS AND CATTLE OF FOREIGN COUNTRIES.

By R. A. PEARSON, B. S., *Assistant Chief of Dairy Division.*

Table VIII gives the number of cows and all cattle in countries where such statistics have been collected. In most cases an earlier and later date are given to show whether stock raising is increasing or decreasing. The figures are taken chiefly from official documents. Other sources of information are the reports of the statistician of the United States Department of Agriculture, the *Statesman's Year Book*, and "*Agricultural Returns for Great Britain*," which latter contains some statistics of the important European countries, as well as of British provinces. Sometimes equally reliable authorities differ. This may be due to reference to different times of the year, or one writer may include a province which the other omits.

In some countries where the number of cattle is very small in proportion to the population there are large numbers of buffalo, reindeer, goats, llamas, or other animals for the supply of milk and meat. The statistics of Japan show that cows are used in that country for transportation and tillage. Remembering these facts and the difference of development of dairying in different countries, it is evident that the number of cows alone does not show the condition of the dairy industry.

Considering the large amounts of our dairy products, the development of our dairy cattle, and the intensity of the industry in many sections, the United States is the leading dairy as well as stock-raising country. In certain small districts of Europe dairying is extensively and successfully carried on. It is not of much importance in sparsely inhabited and semicivilized countries.

Denmark is noted for the large amount of butter of fine quality which is made there. In Bulletin No. 5 of the United States Department of Agriculture, Bureau of Animal Industry, Prof. C. C. Georgeson gives the estimated butter yield of Denmark for 1891 and the number of cattle for 1888. From the available data it is estimated that there were 954,660 cows in Denmark in 1891, which was more than 65 per square mile, and above 439 per thousand persons. This small country is less than one-third the size of New York State, it has a denser population, more than twice as many cows per square mile, and produced in 1891 about five times as much butter per square mile as was made in New York. Its milk and cheese trade is comparatively small. The number of cows per square mile is about the same as in Orange County, N. Y. Nine States of the Union have more cows per thousand persons than Denmark.

In 1893 England and Wales each had about one and one-fifth as many cows per square mile as New York. Ireland, only two-thirds the size of New York, had about the same total number of cows. Wisconsin,

which is twice as large as Scotland, had in 1893 as many cows per square mile as that country possessed in 1890.

Holland is a little smaller than Massachusetts and Connecticut together. It had in 1892 about two and one-half times as many cows per square mile as Iowa in 1890, and almost five times as many as Wisconsin in 1890, and as many cows per thousand persons as Kentucky.

France is four times as large as New York, and has as many cows per square mile. Germany is a little larger than France, and has about one and one-half times as many cows per square mile as New York.

Japan has a smaller number of cows per one thousand persons than any State or Territory, and in 1892 had less per square mile than North Carolina in 1890.

Australian butter has recently come into some prominence in our foreign markets, and it is interesting to note that the leading dairy colony of Australia, Victoria, which is about one and two-thirds times as large as North Carolina, or a little larger than Minnesota, had in 1892 less than 5 cows per square mile, and produced only about 275 pounds of butter per square mile, resembling in these respects North Carolina in 1890.

Canada is our chief competitor in the foreign cheese market. Recent statistics show that its dairy interests per square mile are comparatively small. The appendix to the report of the minister of agriculture for 1893 takes the following from the census of 1890:

	Number.	Capital.	Hands employed.	Wages paid.	Value of raw material.	Value of product.
Cheese factories	1,565	\$2,586,599	3,013	\$753,067	\$6,804,611	\$9,784,288
Creameries	170	540,598	425	106,303	595,421	913,591

From special schedules returned by 451 factories and creameries the following additional information is obtained (the numbers refer to the factory season):

	Average number of days operated.	Cows per factory.	Patrons per factory.	Cows per patron.	Pounds milk for 1 pound of product.	Price of product.	Price of 100 pounds milk at factory.
Cheese factories	177	337	50.55	6.67	10.14	\$0.09+	\$0.77
Creameries	183	330	60.89	5.42	25.26	.20+	.77—

	Average return for milk—		Average number of pounds milk per cow—		Average number of pounds product per cow—	
	Per cow.	Per patron.	Per season.	Per day.	Per season.	Per day.
Cheese factories	\$19.65	\$131.00	2,638	14.90	260.01	1.47
Creameries	18.09	98.10	2,362	12.34	93.54	.51

The following gives the butter and cheese production of Canada, 1890:

	Made in home dairies.	Made in factories.	Total production.
Cheese	<i>Pounds.</i> 6,267,203	<i>Pounds.</i> 108,714,311	<i>Pounds.</i> 114,981,514
Butter	111,370,210	4,567,955	115,938,165

By comparing with the previous tables it will be seen that in 1890 the total cheese production of Canada was less than that of New York, and her butter production was slightly greater than that of New York, but less than that of Iowa.

During the ten years from 1880 to 1890 the production of cheese in Canada increased 80 per cent, and the production of butter 11 per cent. In the same period the cheese production of the United States increased less than 6 per cent, and the butter production 50 per cent. In the same time the number of cows increased 16 per cent in Canada, and over 32 per cent in the United States, and population increased 12 per cent in Canada and 25 per cent in this country. Wisconsin made large increases during this time, as is shown by the following:

Per cent increase in ten years of population, cows, butter, and cheese production in Canada, United States, and Wisconsin.

	Canada.	United States.	Wisconsin.
Population	12	25	28
Number of cows	16	32	66
Cheese production	80	6	180
Butter production	11	50	78

Ontario is the leading dairy province of Canada. It is about four times as large as Michigan and has less than one-half as many cows per square mile. It produces about one-fifth as much cheese per square mile as is made in New York. The 1,011 factories of Ontario made in 1894, 97,284,547 pounds of cheese, valued at \$9,441,247, or 9.7 cents per pound; it required 10.56 pounds of milk for 1 pound of cheese. Patrons received an average of 77.2 cents for 100 pounds of milk. The average Ontario factory manufactures about 100,000 pounds of cheese in a season. In some counties where dairying is a leading branch of agriculture over \$30 worth of cheese is produced per head of the rural population. In the same year, 1894, the 115 creameries made about 3,000,000 pounds of butter, valued at \$628,200, or 20.94 cents per pound.

Manitoba has about the same area and character as North Dakota. It is now making rapid advances in dairying. Twelve of the 19 creameries and 20 of the 42 cheese factories have commenced operations within a year.

Nova Scotia is one-fourth as large as Nebraska. In 1891 these two had about the same number of cows per square mile.

In some countries detailed statistics of cattle are collected. German reports give the number of cattle of different ages, also the number of calves and the proportion of them it is expected will be raised. The agricultural returns for Great Britain give the number of cattle under 1 year, between 1 and 2 years, and over 2 years of age. An example of these details is given below.

Example of foreign cattle statistics—German Empire, 1885.

Horses:		Cattle:	
Colts under 1 year.....	190,022	Calves under 6 weeks.....	512,706
Colts 1 year and under 2 years.....	194,066	Calves 6 weeks to 6 months.....	1,133,133
Horses 2 years and under 3 years..	175,367	Calves 6 months to 2 years.....	3,422,347
Total under 3 years.....	559,455	Total under 2 years.....	5,068,186
Horses 3 years and over:		Number to be raised as bulls.....	91,752
Stallions.....	13,882	Cattle 2 years old and over:	
Horses in agriculture.....	2,228,529	Breeding bulls.....	185,026
Horses in military service.....	107,147	Other bulls and oxen.....	1,445,204
All other over 3 years.....	613,303	Cows.....	9,086,906
Total 3 years and over.....	2,962,861	Total 2 years and over.....	10,717,136
Grand total.....	3,522,316	Grand total.....	15,785,322

Sheep (in three classes)—1, fine woolled; 2, mutton breeds; 3, all others. Lambs, yearlings and over 1 year, in each class.

TABLE VIII.—Cows and cattle of foreign countries for stated years.

[From various authorities.]

Countries.	Years.	Cows.	All cattle.	Years.	Cows.	All cattle.
Algeria	1880		1,163,513	1893		1,233,051
Argentina	1883		*12,000,000	1893		*22,000,000
Australasia	1884		*8,154,701	1892	1,249,720	12,343,453
Australia	1884		7,325,867	1892	994,707	11,351,967
New South Wales	1884		1,336,329	1892	385,110	2,147,074
Queensland	1884		4,266,172	1892	*125,000	6,591,416
South Australia	1884		389,726	1892	79,420	625,887
Victoria	1884		1,262,538	1892	417,177	1,824,704
Western Australia	1884		71,102	1892	*8,000	162,886
New Zealand	1881		698,637	1892	*220,000	821,801
Tasmania	1884		128,834	1892	35,013	170,085
Austria	1880	4,138,025	8,584,077	1890	4,254,303	8,643,936
Belgium	1880	790,178	1,382,815			
Brazil				1891		*17,000,000
Canada	1881	1,595,800	3,434,781	1891	1,829,375	4,090,682
British Columbia	1881	10,878	80,451	1891	17,817	126,729
Manitoba	1881	20,355	60,281	1891	82,614	229,707
New Brunswick	1881	103,965	212,560	1891	104,797	302,439
Nova Scotia	1881	137,639	325,603	1891	135,043	309,776
Ontario	1881	782,243	1,702,167	1894	834,237	2,099,301
Quebec	1881	490,977	950,125	1891	546,986	970,887
Prince Edward Island	1881	45,895	90,722	1891	45,788	91,629
The Territories	1881	3,848	12,872	1891	36,997	233,721
Cape of Good Hope	1875		1,329,445	1893		1,929,800
Ceylon	1884		963,896	1893		1,062,776
Chile	1882		311,000			
Costa Rica				1892		345,605
Cuba				1892		2,485,796
Denmark	1881	898,790	1,470,078	1893	1,011,098	1,696,199
Egypt	1887		462,000			
Finland	1888		966,511	1890		928,276
France	1881	7,290,827	11,576,190	1893	6,005,246	12,154,641
Germany	1883	9,087,293	15,786,764	1892	9,946,164	17,555,624
Greece	1877		279,445	(1)		337,000
Hungary	1880	2,035,217	5,311,378	1884		4,759,393
India				1890		49,635,590
Italy	1881	2,366,556	4,783,252	1890		*5,000,000
Jamaica	1883		84,206	1893		110,720
Japan	1887	598,104	1,020,222	1892	643,500	1,093,638
Netherlands	1880	908,000	1,469,600	1892	893,900	1,528,400
Newfoundland	1875		13,939	1891		23,822
Nicaragua	1884		400,000			
Norway	1875	741,598	1,016,617	1890	705,188	1,004,191
Orange Free State	1881		464,575	1890		*895,099
Paraguay	1882		500,000	1891		861,954
Poland	1888		3,013,392			
Portugal	1882		624,658			
Roumania	1880		*3,600,000	1890		2,520,380
Russia in Europe	1883		23,628,031	1888		24,609,260
Servia	1882		826,550	1891		819,251
Spain	1880		*2,400,253			
Sweden	1883	1,456,504	2,287,013	1893	1,647,400	2,473,981
Switzerland	1876		1,035,930	1886		1,212,538
United Kingdom	1881-85	3,762,931	10,225,379	1895	3,937,590	10,753,314
England	1881-85	1,687,106	4,324,641	1895	1,786,370	4,472,565
Ireland	1885	1,417,481	4,228,851	1895	1,433,960	4,358,041
Island of Jersey				1895	6,748	12,282
Island of Guernsey				1895	3,663	7,519
Isle of Man				1895	7,399	21,136
Scotland	1881-85	400,268	1,116,876	1895	423,967	1,177,947
Wales	1881-85	265,483	668,286	1895	275,483	703,824
United States	1885	13,904,722	43,771,295	1895	16,504,629	50,868,845
Uruguay	1883		6,010,000	1889		8,339,600
Venezuela	1888		8,476,300			

* Official estimates.

† Latest official returns, published 1894.

‡ Average.

TABLE IX.—Population and number of cows per square mile of land surface in each State and Territory in 1890.

	Per- sons.	Cows.		Per- sons.	Cows.		Per- sons.	Cows.
United States.....	21.08	5.56	Maine.....	22.11	5.26	Oklahoma.....	1.59	0.43
Alabama.....	29.36	5.62	Maryland.....	105.72	14.42	Oregon.....	3.82	1.20
Arizona.....	.53	.04	Massachusetts.....	278.48	21.40	Pennsylvania.....	116.88	20.61
Arkansas.....	21.27	6.23	Michigan.....	36.46	8.73	Rhode Island.....	318.44	22.06
California.....	7.75	2.03	Minnesota.....	16.44	7.52	South Carolina.....	38.16	3.53
Colorado.....	3.98	.74	Mississippi.....	27.83	6.74	South Dakota.....	4.28	2.73
Connecticut.....	154.03	26.40	Missouri.....	38.98	12.38	Tennessee.....	42.24	8.27
Delaware.....	85.97	16.62	Montana.....	.91	.17	Texas.....	8.82	3.83
Florida.....	7.22	2.10	Nebraska.....	13.78	6.57	Utah.....	2.53	.56
Georgia.....	31.15	4.88	Nevada.....	.42	.08	Vermont.....	36.39	25.33
Idaho.....	1	.32	N. Hampshire.....	41.81	12.16	Virginia.....	41.27	6.84
Illinois.....	68.23	19.43	New Jersey.....	193.82	21.67	Washington.....	5.22	1.06
Indiana.....	61.05	16.09	New Mexico.....	1.25	.15	West Virginia.....	30.95	7.65
Iowa.....	34.46	27.25	New York.....	125.95	30.24	Wisconsin.....	30.98	14.56
Kansas.....	17.47	9.04	North Carolina.....	33.30	4.60	Wyoming.....	.62	.12
Kentucky.....	46.47	9.11	North Dakota.....	2.60	1.26			
Louisiana.....	24.63	3.72	Ohio.....	90.10	19.50			

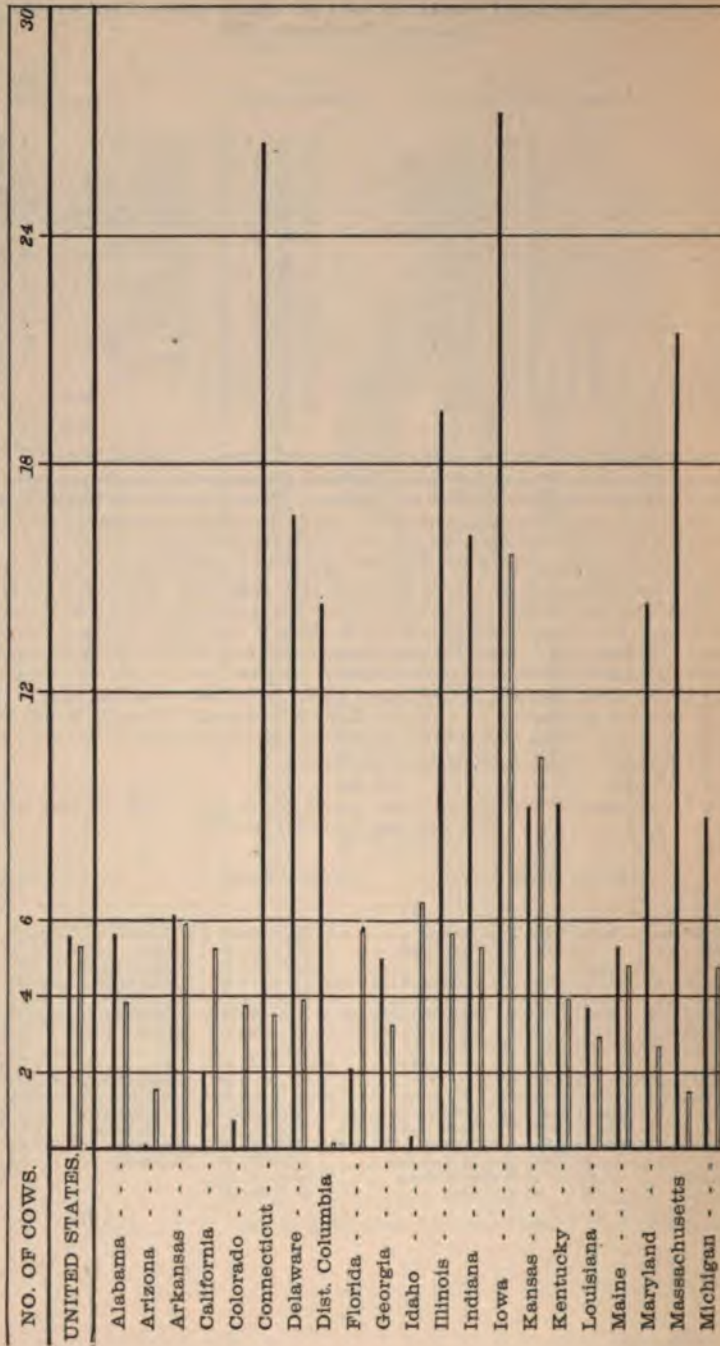
NOTE.—Diagram E, which follows on the next two pages, serves to illustrate Table IX. It shows graphically the number of cows per square mile and the number to each 20 persons; thus two lines are opposite the name of each State and Territory. Twenty persons are taken instead of 100, which might seem more natural, because that is nearly the number of persons to the square mile in the United States, and in the average for the whole country there would be almost as many cows per 20 persons as per square mile. When the upper line is long it indicates that the industry is highly developed, because a large number are carried on a small area. When the lower line is long it shows that dairying is a principal industry, because the number of cows is large in proportion to the population. For example, dairying is highly developed in New York, Iowa, and Connecticut, as is shown by the long upper lines, while the relative importance of the industry, as shown by the lower lines, is much greater in Iowa than in either of the other two. On the other hand, the lower lines for South Dakota, Nebraska, and Minnesota show dairying to be a leading industry, although the upper lines indicate that it is not highly developed in these States. It may be readily seen which States are above or below the average of the country by comparing the lines for any State with those for the whole country, which are at the top of the diagram.

TABLE X.—Pounds of cheese and butter produced per square mile of land surface in each State and Territory in 1889.

	Cheese.	Butter.		Cheese.	Butter.		Cheese.	Butter.
United States.....	86.45	405.90	Maine.....	48.56	568.64	Oklahoma.....	0.04	9.99
Alabama.....	.12	282.27	Maryland.....	2.39	1,100.09	Oregon.....	5.25	52.08
Arizona.....	.10	1.02	Mass.....	47.95	1,294.81	Pennsylvania.....	121.32	2,138.48
Arkansas.....	.40	296.43	Michigan.....	93.51	911.43	Rhode Island.....	299.20	1,105.28
California.....	31.82	173.41	Minnesota.....	54.19	614.58	S. Carolina.....	.08	190.17
Colorado.....	1.27	34.94	Mississippi.....	.11	280.20	S. Dakota.....	7.21	177.75
Connecticut.....	63.68	2,140.20	Missouri.....	24.34	649.42	Tennessee.....	2.42	679.77
Delaware.....	.18	1,272.07	Montana.....	.08	7.31	Texas.....	.56	122.56
Florida.....	.03	15.99	Nebraska.....	16.51	441.11	Utah.....	2.15	22.08
Georgia.....	.22	245.56	Nevada.....	.47	4.46	Vermont.....	677.82	3,108.86
Idaho.....	3.84	12.95	N. Hampshire.....	49.38	1,095.22	Virginia.....	5.44	467.59
Illinois.....	184.80	1,476.34	New Jersey.....	78.77	1,189.37	Washington.....	4.80	52.09
Indiana.....	33.18	1,396.68	New Mexico.....	.15	.70	W. Virginia.....	3.87	571.38
Iowa.....	103.54	2,271.95	New York.....	2,605.77	2,367.23	Wisconsin.....	1,003.03	1,108.46
Kansas.....	33.46	617.32	N. Carolina.....	1.25	270.26	Wyoming.....	.16	4.39
Kentucky.....	1.62	725.96	N. Dakota.....	2.57	87.74			
Louisiana.....	.09	46.01	Ohio.....	545.98	2,000.07			

DIAGRAM E.—*Number of cows per square mile and per 20 persons in each State and Territory, 1890.*

[The upper line (heavy) represents the number of cows per square mile. The lower line (open) represents the number of cows per 20 persons.]



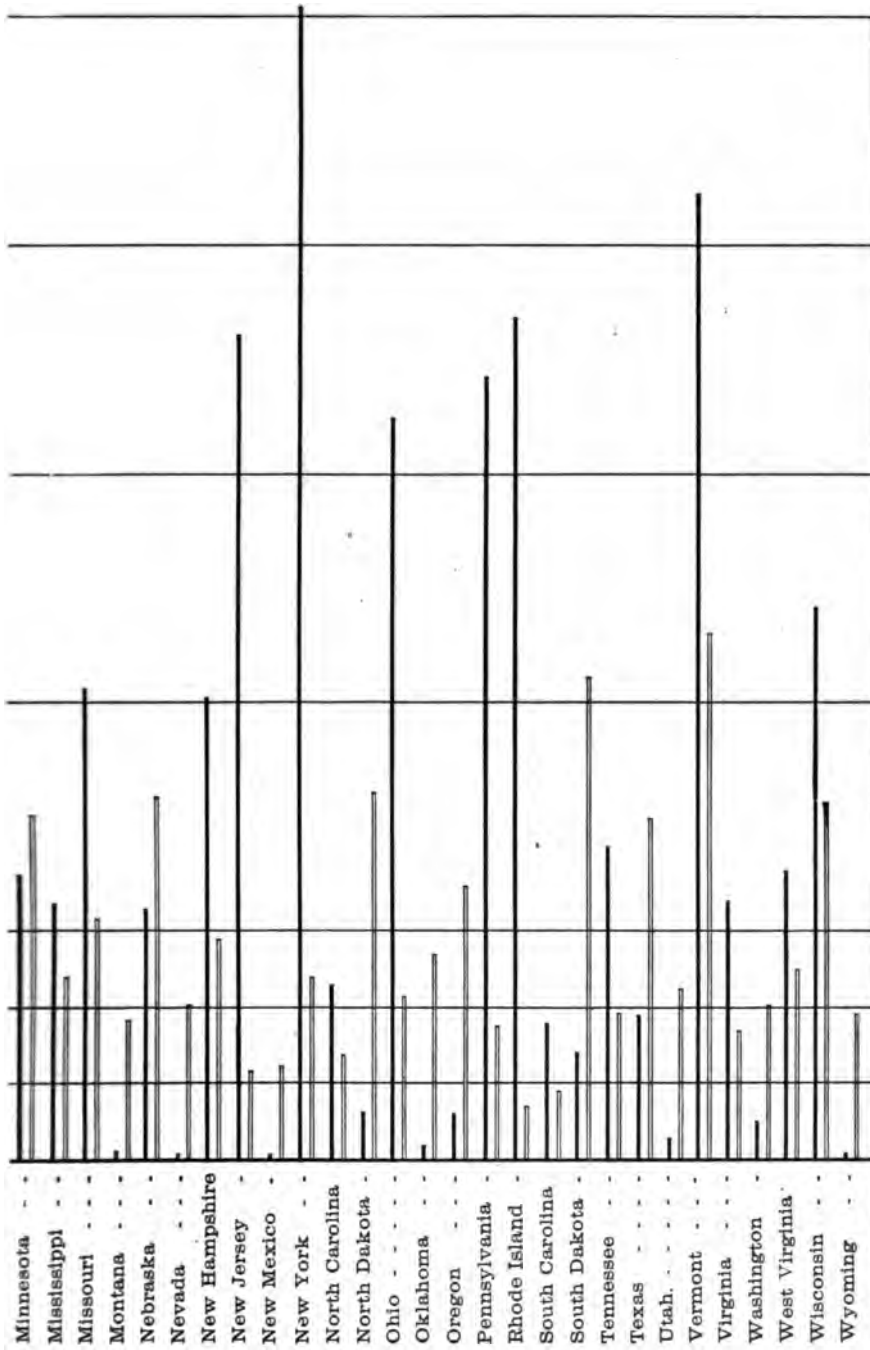


TABLE XI.—Rank of each State and Territory in 1890 in regard to—

	Land area.	Population.	Persons in agri- culture.	Number of cows.	Milk produced.	Butter produced.	Cheese produced.	Persons per square mile.	Cows per square mile.	Butter per square mile.	Cheese per square mile.
Alabama.....	26	17	7	19	24	21	42	25	27	27	41
Arizona.....	5	47	47	48	48	47	41	47	48	47	43
Arkansas.....	25	24	18	16	27	20	36	29	26	26	26
California.....	2	22	24	17	15	17	9	34	36	33	18
Colorado.....	7	31	38	37	36	35	29	38	40	39	32
Connecticut.....	46	29	33	31	26	29	24	4	3	4	11
Delaware.....	47	41	41	40	38	37	48	9	11	10	38
Florida.....	24	32	31	33	43	43	46	35	35	41	48
Georgia.....	19	12	3	20	28	22	39	22	29	30	37
Idaho.....	10	44	44	41	42	41	22	44	43	42	26
Illinois.....	21	3	1	3	4	4	4	10	10	7	6
Indiana.....	37	8	13	11	9	9	15	11	12	8	17
Iowa.....	22	10	12	1	2	1	6	20	2	3	8
Kansas.....	12	19	19	9	8	8	11	30	18	20	16
Kentucky.....	35	11	14	14	13	14	32	12	17	17	31
Louisiana.....	30	25	20	27	37	38	44	27	32	38	44
Maine.....	39	30	27	29	23	19	13	28	28	23	14
Maryland.....	41	27	26	30	30	27	35	7	14	14	29
Massachusetts.....	44	6	28	26	18	28	20	2	7	9	15
Michigan.....	20	9	16	13	7	8	18	19	16	9	9
Minnesota.....	13	20	22	10	11	10	10	31	22	21	12
Mississippi.....	29	21	9	18	29	26	43	26	24	28	42
Missouri.....	17	5	6	6	10	11	12	16	15	19	19
Montana.....	3	43	43	42	41	42	40	45	44	44	46
Nebraska.....	15	26	23	12	12	12	14	32	25	25	20
Nevada.....	6	48	48	47	45	44	34	48	47	45	25
New Hampshire.....	43	33	36	34	31	30	19	14	16	15	13
New Jersey.....	45	18	30	28	20	31	16	3	6	11	10
New Mexico.....	4	42	39	44	47	48	37	43	45	48	40
New York.....	28	1	5	2	1	2	1	5	1	2	1
North Carolina.....	27	16	8	23	25	25	33	21	30	29	33
North Dakota.....	16	40	35	36	32	32	26	40	37	35	27
Ohio.....	33	4	4	7	5	5	3	8	9	6	4
Oklahoma.....	36	45	42	45	46	46	47	42	42	43	47
Oregon.....	9	38	34	32	33	34	18	39	38	37	23
Pennsylvania.....	31	2	15	5	3	3	7	6	8	5	7
Rhode Island.....	48	35	45	43	39	40	21	1	5	13	5
South Carolina.....	38	23	11	35	34	33	45	17	33	31	45
South Dakota.....	14	37	29	24	21	24	17	37	34	32	21
Tennessee.....	32	13	10	15	16	16	30	13	20	18	28
Texas.....	1	7	2	4	14	13	28	33	31	34	34
Utah.....	11	39	40	39	40	39	27	41	41	40	30
Vermont.....	42	36	32	22	17	15	5	19	4	1	3
Virginia.....	34	15	17	21	19	18	25	15	23	24	22
Washington.....	18	34	37	38	35	36	23	36	39	36	24
West Virginia.....	40	28	25	25	22	23	31	24	21	22	25
Wisconsin.....	23	14	21	8	6	6	2	23	13	12	2
Wyoming.....	8	46	46	46	44	45	38	46	46	46	39

NOTE.—The above table is based on data in Tables II, VII, IX, and X. The first three columns show the rank of each State and Territory in size, total population, and agricultural population. The next two columns show their rank in the total number of cows and total milk production. It will be seen that in almost every case where dairying is extensively practiced a State ranks higher in total milk production than number of cows, showing the superior class of stock. The sixth and seventh columns show the rank in the total production of butter and cheese. The last four columns show intensity, and are more interesting in some respects than any of the others. One's opinion of the condition of dairying in any State is often formed by the total production, which depends largely on the size of the State. But some of the small States may have a much higher development of their dairy industry and produce more per square mile than large ones that produce a large total, as is shown in Table X. The ranks of the States and Territories in regard to production per square mile are given in the last two columns.

TABLE XII.—*Neat cattle on ranges in the United States.*

[Census of 1890.]

	Cattle.		Cattle.
Arizona.....	659,758	New Mexico.....	1,054,022
California.....	241,300	South Dakota.....	29,033
Colorado.....	443,681	Texas.....	2,342,083
Indian Territory.....	433,590	Wyoming.....	248,097
Montana.....	756,619		
Nevada.....	78,047	Total United States.....	6,285,220

TABLE XIII.—*Average value of a cow in the United States for the years stated.*

[U. S. Census and Department of Agriculture.]

Years.	Amount.	Years.	Amount.
1850.....	\$20.02	1891.....	\$21.62
1860.....	30.82	1892.....	21.40
1870.....	39.11	1893.....	21.75
1880.....	23.27	1894.....	23.18
1895.....	29.69	1895.....	21.96
1890.....	22.13		

TABLE XIV.—*Registered or pedigreed cattle of selected breeds in the United States and their values (estimates furnished by the secretaries of the respective breeders' associations).*

[From Report for 1885, United States Department of Agriculture.]

Breed.	Registered.	Living.	Average.	Total.
Aberdeen Angus.....		3,500	\$300	\$1,050,000
Ayrshire.....	12,867	6,433	100	643,300
Devon.....	10,187	8,000	81	648,000
Guernsey.....	4,947	3,100	149	461,000
Heresford.....		14,000	300	4,200,000
Holstein-Friesian.....	21,138	20,081	200	4,016,200
Jersey.....	51,000			

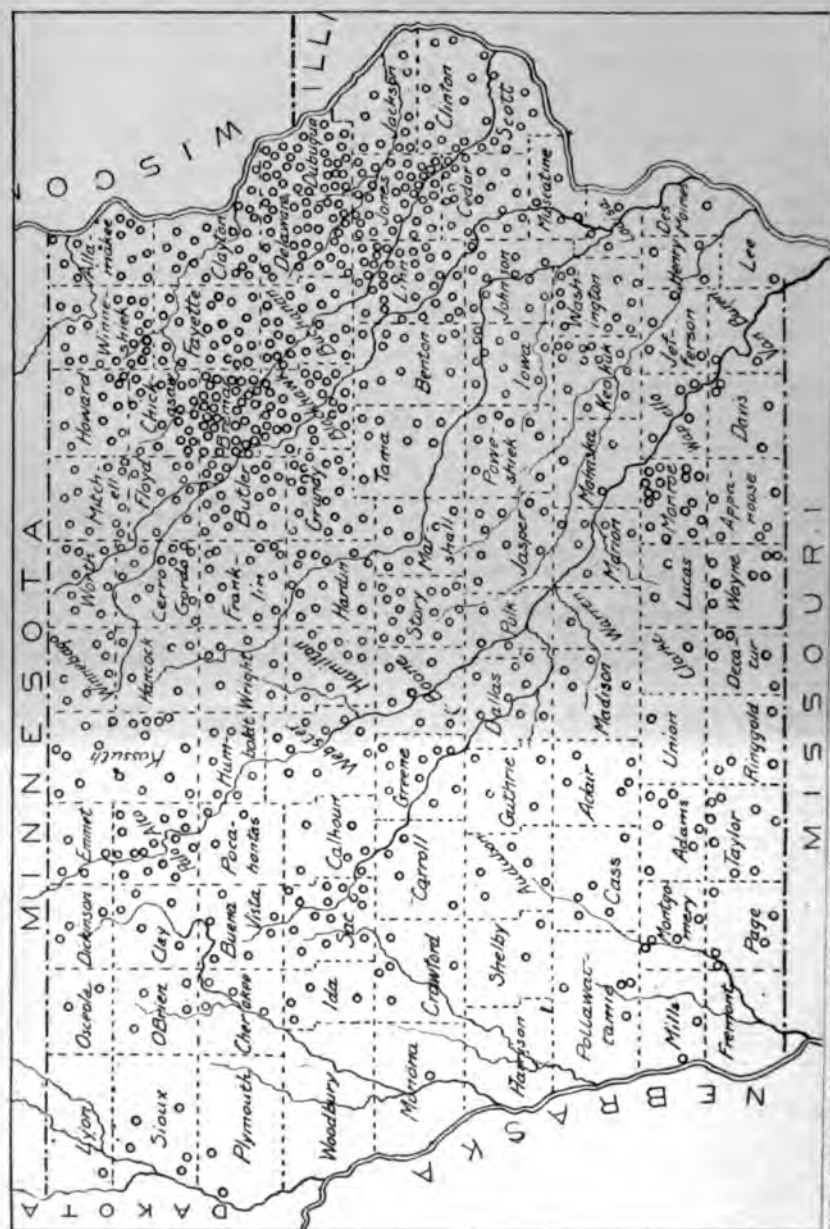
[For the year 1895, as reported to the Dairy Division.]

Ayrshire.....	18,750	9,375	\$100	\$937,500
Brown-Swiss.....	1,930	1,200	150	180,000
Devon.....	17,007	14,500	81	1,174,500
Dutch-Belted.....	971	720	200	144,000
Guernsey.....	12,547	8,500	165	1,402,500
Holstein-Friesian.....	90,325	70,000	100	7,000,000
Jersey.....	150,000	100,000	100	10,000,000
"Maine State" Jersey.....	3,927	2,800	55	154,000
Red Polled.....	4,408	3,000	80	240,000

TABLE XV.—*Growth of the factory system in the United States—States, years, and number of factories, from various sources.*

United States		Connecticut.		Illinois.		Iowa.		Maine.		New York.		Ohio.		Vermont.		Wisconsin.	
Year.	No.	Year.	No.	Year.	No.	Year.	No.	Year.	No.	Year.	No.	Year.	No.	Year.	No.	Year.	No.
1850.....	8	1851.....	1	1862.....	1	1866.....	1	1869.....	1	1851.....	1	1850.....	2	1870.....	28	1841.....	1
1860.....	10	1870.....	7	1874.....	45	1870.....	14	1874.....	40	1861.....	3	1862.....	1	1874.....	32	1864.....	2
1861.....	56	1880.....	16	1875.....	200	1874.....	45	1880.....	41	1864.....	269	1874.....	108	1880.....	85	1865.....	30
1864.....	402	1890.....	50	1890.....	266	1888.....	468	1890.....	42	1865.....	484	1880.....	452	1890.....	124	1872.....	150
1870.....	1,313	.....	.....	1894.....	530	1894.....	870	1894.....	58	1874.....	1,018	1890.....	361	1894.....	250	1874.....	175

The first cheese factory and first creamery were started, respectively, in New York in 1861 and 1864; in Illinois, 1862 and 1870; in Iowa, 1866 and 1871.



OUTLINE MAP OF IOWA, SHOWING DISTRIBUTION OF CREAMERIES (RE-ENGRAVED FROM ANNUAL REPORT OF THE STATE DAIRY COMMISSIONER).

DAIRY STATISTICS RELATING TO SEVERAL STATES, LATER THAN 1890.

[Supplied by various State authorities.]

CALIFORNIA.

[From Louis Tomasini, manager Dairymen's Union of California.]

Cows in the State [1894], total, 333,310.

Used for butter, 207,444; for cheese, 19,200; for the milk trade, 106,666.

Dairy products of State, 1894 (estimated):

31,116,600 pounds butter, at 19 cents.....	\$5, 912, 154
9,000,000 pounds cheese, at 9 cents.....	810, 000
50,000,000 gallons milk, at 12 cents.....	6, 000, 000
Skim milk, etc., made into pork.....	1, 037, 220
Calves (333, 310), at \$2.....	666, 620

Total value average yearly products..... 14, 425, 994

Other California yearly products for comparison: Wheat, \$16,128,381; gold and silver, \$14,000,000; fruits, \$11,025,000; grapes and wines, \$8,150,000; sheep, lambs, and wool, \$7,588,850.

CONNECTICUT.

[From the annual report for 1895, of C. S. Burlingame, State dairy commissioner.]

62 creameries, located in 62 different towns.

Butter produced by same in one year, 4,230,156 pounds.

Average per factory, 68,228 pounds.

NOTE.—Several creameries sell milk and cream mainly, making very little butter.

INDIANA.

[From township assessors' returns, furnished by S. J. Thompson, chief Indiana Bureau of Statistics.]

Cattle and dairy products for April and May, 1895:

Jerseys, 49,136; Holsteins, 9,606; Shorthorns, 55,255; all other, 813,495.

Cattle died in past year, 27,011. Milch cows, 468,043.

Milk produced in year, 145,396,868 gallons; butter made in year, 35,200,916 pounds; cheese made in year, 394,645 pounds.

NOTE.—Figures rather below the facts, as some returns were omitted—for example, about 50 creameries and cheese factories.

ILLINOIS.

[Estimates of dairy products for 1893, made by the Illinois State Dairymen's Association, W. R. Hostetter, secretary, for the souvenir Illinois dairy exhibit, World's Columbian Exposition.]

Value of milk consumed	\$21, 024, 000
Value of condensed milk and cream	1, 022, 000
Illinois milk sent to St. Louis, Mo.....	402, 960
Butter and cheese sold on the Elgin Board of Trade	8, 315, 286
Creamery butter and cheese sold outside the Elgin district	6, 927, 519
Dairy, or farm-made butter.....	31, 000, 000
Skim milk, etc., fed to stock, value.....	7, 000, 000
Total value—annual products	75, 691, 765

IOWA.

[From the annual report for 1895 of W. K. Boardman, State dairy commissioner.]

Creameries, etc.—Of the 99 counties in the State 95 have creameries or cheese factories; 2 counties have only cheese factories. (See map of Iowa upon the opposite page.) Of the 855 establishments reported, 64 were cheese factories, 20 made both

butter and cheese, and the rest only butter; 282 were cooperative concerns, 132 were owned by stock companies, 438 were proprietary, and of 52 the organization or ownership was uncertain; 546 of these creameries use separators, 131 are operated upon the cream-gathering plan, and 106 combine the two systems; 716 receive milk, 456 pay for it on basis of fat tests, and 197 by weight; 525 creameries average 103 patrons each; there are 80,000 creamery patrons in the State; 516 creameries average 854 cows each, and the whole number of cows contributing to Iowa creameries is about 676,000. The total output of the factories for the year is estimated at \$13,300,000 in value, an average of \$15,555 per factory.

Shipments of butter from Iowa by rail: 1890, 71,255,796 pounds; 1891, 68,690,716 pounds; 1892, 60,112,931 pounds; 1893, 54,572,902 pounds; 1894, 52,649,284 pounds.

Estimated home consumption, 20,000,000 pounds for 1894.

Milk.—Eleven cities in the State, having a combined population of 350,073, have 383 wagons and stores which supply the milk from 7,316 cows, to 32,211 families, and 460 hotels and boarding houses. This milk is valued at \$626,460, or \$85.63 per cow. Three thousand nine hundred and thirty-five tests of milk in 1893 gave average of 3.59 per cent of fat; 3,984 such tests in 1894 gave average of 3.79 per cent of fat.

MAINE.

[The secretary of the State board of agriculture, B. Walker McKeen, furnishes returns to that board, and figures from State assessors' returns. All for the year 1894.]

Number of farms	65,400
Number of milch cows	141,262
Value of cows	\$35,314,000
Number of creameries and cheese factories	58
Butter made in creameries, etc. pounds..	2,513,090
Cheese made in factories	500,000
(The returns were regarded as incomplete.)	

MICHIGAN.

[From the State census, June 1, 1894, Washington Gardner, secretary of state.]

Milch cows	506,390
Milk produced on farms	gallons.. 212,070,373
Value milk and cream sold from farms	\$2,970,385
Butter made on farms	pounds.. 49,951,378
Cheese made on farms	do.... 206,660
Value butter and cheese made in factories	\$1,708,431
Creameries, cheese factories, etc	number.. 222
Capital invested	\$810,745
Employees, average number	619
Average wages:	
Skilled laborers	\$1.95
Unskilled laborers	\$1.04
Total wages paid	\$195,564
Number of months in operation, average	7½
Materials used, value	\$1,310,870
Products, total value	1,708,431
(One to six factories not reporting on some items, but do not materially affect these results.)	
Cattle in Michigan, 1894:	
Cows	506,390
Working oxen	11,267
Others, all ages	554,583
<i>Total</i>	1,072,240

Others, by ages:

Under 1 year	242, 220
1 year and under 2	198, 548
2 years and under 3	89, 821
3 years and over	23, 994

Pure-bred cattle, by breeds:

Angus	67
Ayrshire	37
Brown-Swiss	3
Devon	48
Galloway	553
Guernsey	83
Hereford	444
Holstein	1, 714
Jersey	3, 855
Red-Polled	131
Shorthorn	4, 059

MINNESOTA.

[From E. J. Graham, assistant State food and dairy commissioner, and P. D. Wildt, commissioner of statistics.]

Creameries, 1893:

Total number establishments	253
On separator plan	147
Subsidiary skim stations	53
On cream-gathering plan	87
On mixed methods	16
Cooperative creameries	150
Proprietary	72
Owned by stock companies	31

Estimated products, 1893:

Creamery butter, 23,000,000 pounds, at 21 cents	\$4, 830, 000
Farm dairy butter, 7,000,000 pounds, at 15 cents	1, 050, 000
Farm dairy butter, 7,000,000 pounds, at 10 cents	700, 000
Factory cheese, 2,000,000 pounds, at 9 cents	180, 000

Estimated products, 1895:

Creamery butter, 27,000,000 pounds, at 20 cents	5, 400, 000
Value of farm dairy butter	2, 000, 000

NOTES.—Thirty thousand farmers are patrons of creameries; 306 separators are used, of 17 styles and from 5 makers; 92 creameries built in 1892-93 are all on the separator plan and are cooperative concerns. Within the last year reported the proportion of creameries using the separator process has increased from 45 per cent to 60 per cent of the whole, and those operated on the cooperative plan from 42 to 60 per cent. Cheese factories decreased in number from 129 to 65.

Year.	Cows.	Butter.	Cheese.
		<i>Pounds.</i>	<i>Pounds.</i>
1871	106, 016	7, 358, 768	469, 147
1873	155, 454	10, 140, 316	1, 031, 510
1875	178, 278	12, 029, 371	1, 000, 999
1877	200, 379	13, 443, 195	829, 075
1879	225, 516	15, 639, 069	586, 448
1881	221, 213	16, 052, 020	522, 456
1883	288, 896	20, 527, 357	615, 497
1885	339, 933	24, 495, 074	850, 843
1887	392, 027	28, 117, 172	1, 074, 251
1889	412, 036	29, 165, 137	1, 274, 076
1891	424, 881	27, 203, 945	1, 374, 555
1892	411, 349	28, 041, 476	868, 567
1893		35, 864, 832	1, 075, 525

Population of Minnesota: 1870—139,706; 1875—597,407; 1880—780,733; 1885—1,117,798; 1890—1,301,826.

NEBRASKA.

[From S. C. Bassett, secretary State Dairy Association.]

es for 1894:

Number of cows	563,313
Value of cows	\$12,502,886
Creameries, etc	number.. 97
Butter made in creameries	pounds.. 7,072,593
Butter made on farms	do.. 30,669,378
Cheese made in factories	do.. 885,079
do made on farms	do.. 510,214
Total product	gallons.. 159,245,089
Value of total milk	\$11,943,381

NEW YORK.

[From report for 1894, of the Department of Agriculture, Fred. C. Schraub.]

New York has 60 counties; butter and cheese factories are operated in 48 of them.

Butter factories	225
do	1,156
Cheese	213
Establishments	1,624
Creameries, etc	pounds.. 23,218,626
do	do.. 115,760,325

NORTH DAKOTA.

[From reports of State assessors for 1894, compiled by department of agriculture and labor, A. H. Laughlin, commissioner.]

Milk cows, 2 years old and over	114,985
Value of cows	\$1,389,832
Creameries, cheese factories, etc	24
Butter and cheese made in same not given.	
Butter made on farms	pounds.. 4,428,157
Cheese made on farms	do.. 100,891
Milk sold from farms	do.. 791,306

OHIO.

[From the office of the secretary of state, furnished by F. B. McNeal, dairy and food commissioner.]

Milk cows (1893)	583,071
Butter made on farms	pounds.. 49,737,662
Butter made in creameries	do.. 4,177,414
Cheese made on farms	do.. 892,099
Cheese made in factories	do.. 13,824,696
Milk sold from farms, excluding that sent to creameries, etc ..	gallons.. 22,095,825

YEARLY DAIRY PRODUCTS.

[From the Ohio Farmer, 1872.]

Year.	Butter.	Cheese.	Year.	Butter.	Cheese.
	<i>Pounds.</i>	<i>Pounds.</i>		<i>Pounds.</i>	<i>Pounds.</i>
1861	35,442,858	20,637,253	1865	32,450,189	16,947
1862	34,065,629	20,752,097	1866	36,344,606	23,196
1863	31,121,275	19,130,750	1867	34,833,445	19,065
1864	31,141,876	18,097,095	1868	37,005,378	17,814

VERMONT.

[From George W. Pierce, secretary Vermont Dairymen's Association.]

Estimates for 1893-94:

Milch cows	225, 000
Value of same	\$5, 625, 000
Creameries and cheese factories	250
Butter made on farms	pounds 18, 000, 000
Butter made in creameries	do 13, 000, 000
Cheese made on farms	do 1, 000, 000
Cheese made in factories	do 2, 000, 000

(Partially based upon returns.)

WASHINGTON.

[From correspondent in Chicago Produce.]

Estimates for 1895:

Creameries and cheese factories	52
Daily output of same—	
Butter	pounds 7, 000
Cheese	do 2, 400
Annual products of the State—	
Butter	pounds 2, 190, 000
Cheese	do 547, 000
Consumption—	
Butter	pounds 2, 920, 000
Cheese	do 730, 000

NOTE.—In 1891 the State produced only 5 per cent of the butter and cheese there consumed.

WISCONSIN.

[From the State census of 1895, furnished by H. C. Adams, dairy and food commissioner.]

Farms	150, 801
Milch cows	842, 039
Value of cows	\$17, 442, 144
Creameries	753
Cheese factories	1, 337
Butter made on farms and in creameries	pounds 74, 653, 730
Cheese made on farms and in factories	do 52, 480, 815
Milk produced on farms, estimated	gallons 315, 000, 000
Value of annual dairy products, estimated	\$30, 000, 000







BULLETIN No. 13.

**U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.**

TUBERCULOSIS INVESTIGATIONS.

THE GROWTH OF THE TUBERCULOSIS BACILLUS UPON ACID MEDIA.

By E. A. DE SCHWEINITZ and MARION DORSET.

FURTHER EXPERIMENTS WITH AN ATTENUATED TUBERCULOSIS BACILLUS.

By E. A. DE SCHWEINITZ and E. C. SCHROEDER.

THE EFFECT OF TUBERCULIN INJECTIONS UPON THE MILK OF HEALTHY AND DISEASED COWS.

By E. A. DE SCHWEINITZ.

Prepared under the direction of
Dr. D. E. SALMON,
Chief of the Bureau of Animal Industry.

Issued September 19, 1896.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.



LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., July 15, 1896.

SIR: I have the honor to transmit herewith, and to recommend for publication as a bulletin of this Bureau, the manuscript containing a report of investigations upon the cultivation of the tuberculosis bacillus upon acid media, and of some further experiments with reference to the effect of tuberculin upon the milk of cows.

These experiments have been conducted under the immediate supervision of Dr. E. A. de Schweinitz, assisted by Drs. Marion Dorset and E. O. Schroeder, and the publication of the results obtained will furnish a convenient and desirable method of preserving and distributing the results of scientific investigations in this important part of the work of this Bureau.

Very respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

LETTER OF SUBMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
Washington, D. C., July 1, 1896.

I submit for publication some results of investigations
concerning the action of the tubercle bacillus upon acid media, the
virulent character of an attenuated tuberculosis bacillus, and some
other experiments with reference to the effect of tuberculin upon the
system of cows. Charts showing the average temperature reactions of
cattle as regards breed are also appended.

Respectfully,

E. A. DE SCHWEINITZ,
Chief Biochemic Division.

Dr. D. E. SALMON,
Chief of Bureau of Animal Industry.

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7. Average temperature reaction of Grade cattle

TUBERCULOSIS INVESTIGATIONS.

THE GROWTH OF THE TUBERCULOSIS BACILLUS UPON ACID MEDIA.

By E. A. DE SCHWEINITZ, Ph. D., M. D., and MARION DORSET, M. D.

INTRODUCTION.

In the Philadelphia Medical News of December 8, 1894, one of us (De Schweinitz) published an article upon the attenuated bacillus tuberculosis and its effect upon guinea pigs, and called attention to the fact that the tuberculosis germ would grow satisfactorily upon media having an acid reaction. This appeared to be an important observation, and while we have for several years been cultivating the tuberculosis germ upon various media, some interesting facts have been noted which are worthy of record.

Pawlosky, Ann. de l'Institut Pasteur, 1888 (and Sander) (Archiv für Hyg., Bd. XVI, p. 238) have shown that vegetable broths may be used for the cultivation of the bacillus tuberculosis, and (in the Centralb. für Bak. und Parasit., August 8, 1895, Nos. 4, 5) Lubinski describes the utilization of this acid broth in the preparation of solid and liquid media, either with or without the addition of beef broth.

Our cultures have been made upon the ordinary peptonized meat broth prepared from fresh meat and upon the artificial media, which, as one of us noted earlier, has been very useful in studying the products of germs. We find that the tuberculosis bacillus will grow upon acid beef broth which requires 21.6 c. c. $\frac{N}{10}$ sodium hydrate solution to neutralize every 100 c. c. of the media. It will also grow upon acid artificial media every 100 c. c. of which requires 45 c. c. of $\frac{N}{10}$ sodium hydrate solution for neutralization. This acidity in some instances was due to the acids in the meat. In the artificial media it was due to the acid phosphate of potassium used.

We have also added free hydrochloric acid to the acid beef broth and to the acid artificial media, so that from 1 c. c. to 3 c. c. $\frac{N}{2}$ hydrochloric acid have been contained in every 100 c. c. of the media. The presence of free hydrochloric acid was tested, both before and after the sterilization of the media, and after the bacilli had begun to multiply, by means of congo red or phloroglucin and vanillin. The congo-red

test was not satisfactory in the beef broth, the albuminoids and possibly organic acids present evidently interfering with the reaction. The phloroglucin and vanillin test, however, proved conclusively the presence of free hydrochloric acid in the media, upon which there was a good growth of the tuberculosis bacillus. The exact quantity of the free hydrochloric acid present in these cultures could not be readily determined, as when hydrochloric acid was added to the media a portion apparently first decomposed the organic salts and phosphates.

After the growth of the tuberculosis germ is well advanced upon the media described and has apparently ceased, the acid reaction of the cultures is still more marked, requiring for the neutralization of the acid substance produced by the germ to every 100 c. c. of culture 12.5 c. c. to 15 c. c. $\frac{N}{10}$ sodium hydrate.

Lubinski notes a decided variation in the morphology of the germ as grown upon the acid vegetable broth. The bacilli, he says, often appear in long filaments, having, however, the same thickness that the germs usually possess. The filament forms described by Metschnikoff, Fischel, and Jones varied in thickness, showed side chains, and were not joined, while Lubinski reports characteristic streptococci-like formation. Jones could find this filamentous growth only after the cultures were four to five months old. Lubinski observed it in ten days.

OBSERVATIONS.

Our observations upon the character of the germs grown upon acid beef broth media and their morphological changes are somewhat different. Instead of a thread-like growth or chain growth we have often found what appeared to be spores, and sometimes the bacilli seem very much thicker and longer than the ordinary germs. In one culture examined the germ had been from generation to generation during four years grown on acid media and might be expected to show Lubinski's chain-like formation, but instead there was an apparent spore formation perceptible.

The appearance of the germs grown upon our acid media can be seen from the accompanying plates. Pl. I, fig. 1, shows the bacillus grown upon glycerin beef broth for four months; Neisser's spore stain. Pl. I, fig. 2, shows the bacillus grown for forty generations upon an acid media.

The filament forms are not observed. There is a slight thickening of the bacillus and rounding at the end often noted, which would appear to be spore formation. There is a different change in the morphology of the germ as grown upon our media which confirms the conclusions of Lubinski that we have heteromorphic forms of the tuberculosis bacillus and a genuine pleomorphism caused by the changed conditions of life. Bruns (*Centralblatt für Bak. und Parasitenkunde*, Bd. XVII, Abth. I, No. 23) describes a germ which gives Neisser's spore reaction and in that particular evidently corresponds to the ones we have pictured.



FIG. 1.—Seventh generation in glycerine beef broth.
Neisser's spore stain. ($\times 2000$.)



FIG. 2. Fortieth generation, acid media.
Neisser's spore stain. ($\times 2000$.)

Haines, del.





FIG. 1.—Culture containing free hydrochloric acid.
Neisser's spore stain. ($\times 2000$.)



FIG. 2.—Artificial culture. Neisser's spore stain.
($\times 2000$.)

Haines, del.

BACILLUS TUBERCULOSIS UPON ACID MEDIA CONTAINING FREE HYDROCHLORIC ACID, AND
UPON ARTIFICIAL MEDIA.

Pl. II, fig. 1, shows the germ grown upon acid media containing free hydrochloric acid.

Pl. II, fig. 2, is a drawing of the tuberculosis germ grown on artificial media. We do not here observe quite the same change in the morphology of the germ.

DETAILS OF EXPERIMENTS.

A more detailed description of our experiments may be interesting. The reaction of the media prepared for the cultivation of the tuberculosis germ was not changed in the process of sterilization. A quantitative check of the amount of acid was made before and after this process.

First experiment.—The media used for this experiment was alkaline and required for neutralization 1 c. c. $\frac{N}{2}$, hydrochloric acid for every 50 c. c. of the media.

a. To each of 2 flasks 50 c. c. each, 5 c. c. $\frac{N}{10}$, NaOH were added.

b. To each of 2 flasks 50 c. c. each, 20 c. c. $\frac{N}{10}$, NaOH were added.

c. To each of 2 flasks 50 c. c. each, 1 c. c. $\frac{N}{2}$, HCl were added.

The six were inoculated at the same time with tuberculosis bacilli from (A 14). Within two weeks a good growth of the germ was noted over the surface of flasks a and c, while b showed no growth at all.

Second experiment.—The media used required for neutralization 8.4 c. c. $\frac{N}{10}$, sodium hydrate solution for every 50 c. c.

a. To each of 2 flasks 50 c. c. were added 8.4 c. c. $\frac{N}{10}$, NaOH.

b. To each of 2 flasks 50 c. c. were added 1.3 c. c. $\frac{N}{2}$, HCl.

a flasks were neutral and b flasks acid. The two sets were inoculated from the same culture (A 15). Within two weeks the germs in both flasks were growing well, a perhaps a trifle better than b. At the end of seven weeks one flask, a, was titrated and required for neutralization 6.3 c. c. $\frac{N}{10}$, NaOH. This flask had been neutral when inoculated.

b flasks required 22.5 c. c. $\frac{N}{10}$, NaOH for neutralization. The increase in acid in a flasks is represented, therefore, by 6.3 c. c. $\frac{N}{10}$, NaOH, and in the b flasks by 7.5 c. c. $\frac{N}{10}$, NaOH. There was apparently a larger amount of the acid substance formed in the acid flasks than in those which were neutral at the time of inoculation.

Third experiment.—The media used required for neutralization 6.6 c. c. $\frac{N}{10}$, NaOH for every 100 c. c. of liquid.

flasks 100 c. c., 1 c. c. $\frac{N}{2}$, HCl was added.

each of 2 flasks 100 c. c., 2 c. c. $\frac{N}{2}$, HCl were added.

To each of 2 flasks 100 c. c., 3 c. c. $\frac{N}{2}$, HCl were added.

These flasks were all inoculated with a virulent germ, and although required several weeks for the growth to begin, after four weeks there was growth in all of the cultures, the most acid ones seeming to attain as good a growth as the others. Every 100 c. c. of the *a* media required 11.6 c. c. $\frac{N}{10}$, NaOH.

Every 100 c. c. of the *b* media had required 16.6 c. c. $\frac{N}{10}$, NaOH.

Every 100 c. c. of the *c* media had required 21.6 c. c. $\frac{N}{10}$, NaOH for neutralization.

experiment.—The media used in this experiment was the same as described by Dr. Schweinitz—in 1892, and it

NaOH for 100 c. c. for neutralization.

100 c. c. of the media as

100 c. c. of the media as with the addition of 2 c. c.

chloric acid.

These were inoculated from another artificial culture, and both within fifteen days showed a good growth, the one containing hydrochloric acid showing a slightly better growth than the other.

Drs. Trudeau and Baldwin have pointed out that the apparent retardation of the growth of the tuberculosis bacillus by the acid reaction of the media can be overcome by neutralization. This is true; but we have also found that if the germ is transferred from an acid culture after it has been cultivated on acid media for a number of months to a neutral nutrient fluid it will no longer grow. There would seem from this to be probably a poisonous principle secreted by the germ. It may be a true acid or, more likely, a substance with an acid reaction. In the experiment, as the germs used for inoculation still floated on the surface of the culture they should have been alive unless some substance especially inimical to their growth was produced in the cultures.

These experiments show clearly that the tuberculosis bacillus can be readily accustomed to an acid nutrient fluid, that it can easily adapt itself to the changed conditions of life, and that even a small amount of free hydrochloric acid does not interfere with its growth. They tend to show further, we think, that under certain conditions there is probably a poisonous substance produced by the germs which is inimical to their own life.

The adaptability of the bacillus to a variety of media can best be explained by spore formation.

MARCH 14, 1896.

FURTHER EXPERIMENTS WITH AN ATTENUATED TUBERCULOSIS BACILLUS.

By E. A. DE SCHWEINITZ, Ph. D., M. D., and E. C. SCHROEDER, M. D. V.

In the Medical News, December 8, 1894, one of us (E. A. de Schweinitz) briefly described an attenuated tuberculosis bacillus (human), and noted that while originally very virulent, by a special method of cultivation it had been rendered very harmless, and not only failed to produce disease in guinea pigs and rabbits, but in some instances imparted to animals inoculated with it a distinct resistance to tuberculosis upon a subsequent inoculation with a virulent germ. The experiments with this attenuated germ have been continued, and we desire to present further evidence of the apparent absolutely harmless character of this attenuated germ, reserving for a later article further reports of its immunizing properties.

EXPERIMENT WITH A MONKEY.

After a number of guinea pigs and cattle had been inoculated with this attenuated germ it seemed desirable to test its effect upon an animal susceptible to tuberculosis and more like man. Accordingly a monkey placed at our disposal by Dr. Kinyoun was inoculated on September 10, 1895, with $\frac{1}{2}$ c. c. of an emulsion of a tubercle culture thirtieth generation. The inoculation was made from a culture in which there was an active growth.

On September 28, 1895, the injection with this material $\frac{1}{2}$ c. c. of tuberculosis culture thirty-second generation was repeated, and again on January 20, 1896, 2 c. c. of tubercle culture thirty-third generation. At the seat of the first and second injections small nodules were formed, while no local lesion was noted at the seat of the third injection.

On April 9 the monkey was found dead. It had not been well for three weeks and was quite sick during the five or six days immediately preceding death. It had no appetite, the hair was rough, there was nausea and great thirst and evidence of distress. Post-mortem examination revealed congested lungs and an inflammatory condition of ileum and caecum. Dr. Schroeder says "there were no signs of tuberculosis and the small nodules formed at the time of the first two injections had become absorbed." This attenuated germ was, therefore, innocuous to the monkey, though, as noted before, it had been obtained from an originally very virulent germ.

RESULTS OF GUINEA PIG INOCULATIONS.

The guinea pig inoculations made by one of us (Schroeder) with this attenuated germ to test its virulence were as follows: November 24, 1894, Nos. 280, 281, 282, and 283 received each an abdominal injection subcutaneously of $\frac{1}{2}$ c. c. tubercle culture twenty-third generation.

On January 25, 1895, each pig again received 1 c. c. tubercle culture twenty-sixth generation. October 7, 1895, guinea pig No. 281 was found dead. A small dry, cheesy nodule at the seat of one injection was noted, but there was no other evidence of tuberculosis, and death resulted from inflammation of the bowels.

On January 3, 1896, guinea pig No. 282 was found dead from pneumonia. There was no evidence of tuberculosis. The other two pigs, Nos. 280 and 283, are alive and well at this time.

Guinea pigs Nos. 55, 56, 57, 58, and 59 were inoculated on October 2, 1895, subcutaneously with 1 c. c. tubercle culture thirty-second generation. On October 17 guinea pig No. 55 was found dead, and post-mortem revealed a general inflammatory condition of subcutaneous tissue over entire abdomen. The other animals, Nos. 56, 57, 58, and 59, are alive and well at this writing.

Again, January 25, 1895, guinea pigs Nos. 331 and 332 were inoculated with $\frac{1}{2}$ c. c. tubercle culture twenty-sixth generation. On December 30, 1895, guinea pig No. 331 was found dead from pneumonia. The liver had a peculiar mottled appearance and a few yellowish patches. Though a coverglass preparation showed no tubercle bacilli, two pigs, Nos. 121 and 122, were inoculated as checks with a portion of the liver. After the lapse of six months they are alive and well and show no symptoms of disease.

On February 19, 1895, guinea pig No. 332 was also found dead, death being due to inflammation of the bowels, and there was no evidence of tuberculosis.

These inoculations made by Dr. Schroeder have confirmed the earlier experiments made by Dr. De Schweinitz, and agree with the following which have been repeated as a check on the first work. They show conclusively that from an originally virulent germ we have succeeded in obtaining an attenuated germ which, even in large doses, is apparently harmless to guinea pigs, rabbits, cattle, horses, and monkeys.

November 15, 1895, six guinea pigs were inoculated with $\frac{3}{4}$ c. c. each of an emulsion of an attenuated culture thirty-fourth generation. The pigs weighed as follows:

Ounces.		Ounces.	
No. 67.....	9	No. 70.....	11 $\frac{1}{4}$
No. 68.....	11	No. 71.....	8 $\frac{1}{4}$
No. 69.....	11	No. 81.....	12

November 18 No. 67 was found dead from pneumonia. The other animals exhibited the following condition on subsequent dates:

December 13, 1895.

Guinea pig.	Weight.	Remarks.
	<i>Ounces.</i>	
No. 68.....	12	Slight local swelling; no enlarged glands.
No. 69.....	14	Do.
No. 70.....	13	Do.
No. 71.....	10	Slight local swelling, right inguinal gland enlarged.
No. 81.....	14	Slight local swelling; no enlarged glands.

December 31, 1895.

Guinea pig.	Weight.	Remarks.
	<i>Ounces.</i>	
No. 68.....	14	Slightly enlarged glands.
No. 69.....	16	No enlarged glands.
No. 70.....	15	Do.
No. 71.....	11	Do.
No. 81.....	14	Slightly enlarged gland.

No tuberculosis was evident on autopsy of one of these, showing that the germ was without pathogenic effect. The animals had steadily gained in weight.

Again:

Guinea pig.	Weight.	Guinea pig.	Weight.	Guinea pig.	Weight.
	<i>Ounces.</i>		<i>Ounces.</i>		<i>Ounces.</i>
No. 166.....	15	No. 170.....	14	No. 174.....	15
No. 167.....	13	No. 171.....	11	No. 176.....	14
No. 168.....	14	No. 172.....	16	No. 159.....	10
No. 169.....	10	No. 173.....	16	No. 164.....	10

These animals were all inoculated on February 5, 1896, with 1½ c.c. of attenuated tuberculosis culture thirty-seventh generation. On February 13, 1896, the weights of these animals were as follows:

Guinea pig.	Weight.	Remarks.
	<i>Ounces.</i>	
No. 169.....	9	Swelling size of a pea at point of inoculation.
No. 172.....	15½	Do.
No. 174.....	15	Do.
No. 159.....	10	Do.
No. 170.....	12½	Large swelling at point of inoculation.
No. 168.....	14	Slight swelling at point of inoculation.
No. 171.....	10	Do.
No. 173.....	14	Do.
No. 164.....	8	Slight swelling; pneumonia.
No. 166.....	14	Do.

On February 8 and 10, respectively, guinea pigs No. 167 and 176 were found dead from pneumonia, which they had contracted from exposure to cold. Subsequently guinea pigs Nos. 174, 172, 159, and 171 were

neumonia. On March 16, 1896, guinea pig No. 169, inoculated on February 5, with the attenuated germ and dead. There were no signs of tuberculosis, although the pig had been inoculated over a month. The pig died from pneumonia. On March 10, 1896, the record of the remaining animals was as follows:

Guinea pig.	Weight.	Remarks.
	Ounces.	
.....	15	Slight sore at point of inoculation.
.....	9	No local lesion.
.....	16	Slight sore at point of inoculation.
.....	10	Apparently well.
.....	14	Do.

Guinea pig.	Weight.	Guinea pig.	Weight.	Guinea pig.	Weight.
	Ounces.		Ounces.		Ounces.
.....	16	.....	10 1/2	April 7, 1896:	18
.....	10	.....	16 1/2	No. 168	16
.....	14	.....	16	No. 166	10
.....	14	.....	13 1/2	No. 170	12
				No. 173	12

ment indicating the beginning of a disease in pigs Nos. 170 and 173, but as there was no evidence of tuberculosis.

These and other cases in which the guinea pigs were inoculated with the attenuated germ, and after one to two years showed no evidence of disease, have proved conclusively the attenuated character of this germ. Although this germ is so attenuated and innocuous to animals, its ability to grow in artificial media is as good and better than ever, and the tuberculin obtained from its culture is as satisfactory as that prepared from a more virulent germ.

Cows and calves have also been inoculated with this attenuated germ in doses varying from 2 to 500 c. c. at a time without the production of tuberculosis. Nodules were frequently formed at the point of inoculation, which seemed, however, to be due to the mechanical action of the germ, and did not produce any evidence of tuberculosis.

JUNE 29, 1896.

THE EFFECT OF TUBERCULIN INJECTIONS UPON THE MILK OF HEALTHY AND DISEASED COWS.

By E. A. DE SCHWEINITZ, Ph. D., M. D.

Continuing the line of experiments given in my report, Bulletin No. 7, Bureau of Animal Industry, upon the variation in the amount of fat in the milk before and after the injections of tuberculin, tests were made on different dates upon a healthy cow, No. 299, with varying doses of tuberculin, upon diseased animals Nos. 145 and 161, and also upon a set of eight different animals taken from the same milch herd—Nos. 185, 186, 187, 189, 194, 195, 222, and 234. The latter had all been condemned by the tuberculin test, and preparatory to their being killed were kept at the station for some days, thus giving an opportunity for testing their milk. There was practically no variation in the fat of the milk from the healthy cows after the tuberculin injection. This agrees with our first experiments, and also with some tests made by Dr. Law, reported in Cornell University Bulletin No. 7. Neither was there any alteration when, as is seen from the tests in March on No. 299, large doses, 30 c. c. of tuberculin, were injected. The second and third injection with tuberculin of No. 145 and 161, diseased respectively, caused no appreciable rise of temperature, but there was a decided decrease in the amount of fat.

In the series of January 16, 1895, however, the two animals that showed no rise in temperature failed to show any decrease in the milk fat. When the rise of temperature was noted in the others a marked decrease in fat was also noted.

A comparison of the decrease in fat with the extent of the disease, as revealed by autopsy and given me by Dr. Smith, except in case No. 234, a generalized one, does not apparently show any relationship. The oldest cases seemed to give the least change in fat—No. 185—while the newer cases gave the largest variation. The Tables I and II show the quantity and composition of the various samples of milk, and the Tables III and IV the temperature reactions after the tuberculin injection, for the corresponding dates.

No. 285, an animal condemned for tuberculosis about a year ago, has been kept at the station since that date. At first she was injected with small doses of tuberculin until she ceased to give a reaction and was again apparently well. The injections of tuberculin were increased in number and quantity, and on March 20, 1895, the date of the last examination of the milk, the animal received an injection of 100 c. c.

Previous to that date she had received altogether 565 c. c. of tuberculin. The last injection caused no change in the amount of fat or in the temperature.

The variation in fat should, of course, be attributed in part to the fever. But that this is not the only cause is also evident. The variation is not, judging from the few tests made, sufficient of itself to prove the presence of tuberculous, but taken in conjunction with the rise of temperature might be considered as corroborative evidence. The tuberculin tests were made by Drs. Schroeder and Curtice, while in the milk analyses I was assisted by Mr. J. A. Emery.

In this connection are appended several charts with curves which show the average variation in temperatures of a number of different animals. These were tabulated in February, 1895, from the reports received from the different States to which tuberculin had been sent.

Chart No. 1 shows the average temperature of a number of animals, without reference to breeds. The other charts are arranged so that all animals of the same breed are placed together. The diagnoses were not in all cases proved by slaughtering the animals, but in all cases where they were killed the autopsies confirmed the diagnoses.

The weights of the animals were taken as the average weight, and the dose of tuberculin was 2 c. c. The Holstein cattle showed apparently a slightly higher reaction than the others. The temperature curve begins at the time of injection, and the first temperatures then noted are six hours after the injection with tuberculin.

The upper line in the charts shows the reaction of the diseased animals, and the lower of healthy ones. In order to make the charts smaller, an average was made of the temperatures of the different animals taken before the injection. From four to eight temperatures were taken of each animal, and the general average thus obtained with a large number of animals is given as the average normal temperature.

In the chart giving the curve for the whole number of animals there is a rise of temperature noted after twenty hours. This is due to the Holstein chart, which is included. The late reaction noted in these animals, which were from different herds, may be due to their larger size.

Many objections have been made against the use and reliability of tuberculin as a diagnostic agent, the opposition coming principally from those who are to a great extent unfamiliar with its practical use or who are only too ready to condemn a material which, through lack of skill and knowledge on their part, has perhaps given unsatisfactory results. The committee in Paris, composed of Cheveau, Leblanc, Mequin, Nocard, Strauss, Trasbot, and Weber, reported as follows upon the principal objections to the use of tuberculin: "The use of high temperatures and carbolic acid in the manufacture of tuberculin makes it impossible that the tuberculin, if properly prepared, should produce disease. It occasionally happens that tuberculin fails to give a reaction in diseased animals, but these are very exceptional cases, and occur

only sometimes when the animals are very badly diseased and their condition could be easily recognized, and are not of importance. Occasionally, also, apparently healthy animals show a reaction, but when a very thorough and careful autopsy is made evidence of the disease is usually found. In a case of an apparently healthy animal, therefore, one can only say in safety that the examination had not been sufficiently close to discover the lesions. Again, in cases where there was apparently some other disease and the tuberculin injection caused a reaction a careful autopsy has shown the presence of tuberculosis, and that the reaction was due to the latter disease." This disposes of the objection that the tuberculin reaction is not characteristic.

The statement that the tuberculin injection causes the disease to spread more rapidly is not warranted by facts, and in many instances the use of tuberculin has apparently caused an improvement in the disease.

One animal, originally tuberculous, kept at the station of the Bureau of Animal Industry, has received about 3,000 c. c. tuberculin in different injections, extending over a long time. This animal is now well and fat and has entirely recovered from tuberculosis.

In 1895 the International Congress for Veterinary Medicine, at Berne, said: "Tuberculin is a most excellent diagnostic material, and can be of the utmost service in the warfare against tuberculosis." This resolution was indorsed by the French Academy of Medicine and the use of tuberculin was generally recommended. The satisfactory reports received from the different States to which this Bureau has sent tuberculin are confirmatory of the results obtained, and prove that tuberculin is the only effective means at hand to insure a rapid eradication of tuberculosis in cattle. A table showing the results of the tuberculin injection of more than 50,000 cattle will appear in the next Annual Report of the Bureau.

FEBRUARY, 1895.

1992—No. 13—2

TABLE I.—*Analyses of milk of cows injected with tuberculin.*

No. of animal.	Date.	Quantity.	Specific gravity.	Total solids.	Sugar.	Albuminoids.	Fat.	Ash in milk.	Total fat acid. (a)	Volatile fat acid. (b)	Acidity. (c)
299	1894.	c. c.		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	c. c.	c. c.
	Dec. 11	9,655	1.032	13.65	3.84	3.14	4.48	0.70	.....	6.7	0.132
	Dec. 12	9,655	1.031	14.54	4.17	2.91	6.31	.70	.....	5.0	.146
	Dec. 13	8,519	1.029	13.38	3.84	2.00	5.10	.62	.....	3.9	.108
	Dec. 14	9,087	1.029	13.11	4.16	2.86	4.10	.66	.....	6.6	.112
	Dec. 18	7,950	1.028	12.74	3.33	2.50	5.49	.60	.....	4.7	.132
	Dec. 11	2,000	1.018	21.61	5.00	3.21	15.34	.75	.....	3.5	.109
	Dec. 12	1,785	1.025	14.68	2.94	3.13	7.73	.75	.....	3.9	.136
	Dec. 13	3,407	1.026	14.95	2.38	3.49	7.16	.72	.....	5.0	.130
	Dec. 14	3,407	1.027	15.03	3.12	3.61	7.21	.76	.....	4.8	.134
145	Dec. 18	3,407	1.027	16.26	2.77	3.75	8.18	.78	.....	4.8	.114
	Dec. 11	1,450	1.020	18.88	2.50	3.04	12.56	1.01	.....	2.8	.072
	Dec. 12	1,025	1.027	12.99	2.63	3.05	5.52	.77	.....	5.5	.072
	Dec. 13	1,703	1.026	12.77	2.77	2.99	4.09	.74	.....	7.5	.102
	Dec. 14	1,703	1.026	12.92	2.94	3.06	4.91	.73	.....	6.1	.110
161	Dec. 18	1,703	1.026	13.73	2.63	3.16	6.35	.81	.....	5.1	.090
	1895.										
	Jan. 3	10,222	1.034	12.61	3.57	2.78	4.26	.78	.....	3.3	.140
	Jan. 4	9,087	1.033	12.34	3.57	2.81	3.30	.70	.....	.....	.150
	Jan. 8	10,222	1.032	12.45	3.57	2.96	3.87	.69	.....	7.2	.108
145	Jan. 9	9,087	1.034	12.58	3.84	2.13	3.86	.67	.....	7.2	.156
	Jan. 10	9,654	1.033	12.95	3.84	2.51	4.06	.61	.....	7.5	.154
	Jan. 3	3,407	1.028	16.97	2.77	3.36	10.14	.86	.....	1.4	.100
	Jan. 4	3,407	1.030	15.40	3.12	3.05	7.87	.76	.....	1.9	.156
	Jan. 8	3,091	1.030	15.68	3.12	3.56	7.44	.75	.....	1.9	.122
	Jan. 9	3,407	1.031	16.74	2.94	3.86	8.35	.73	.....	4.9	.138
	Jan. 10	3,123	1.028	15.38	3.12	3.58	6.54	.70	.....	5.3	.138
	Jan. 3	1,703	1.030	17.54	2.94	3.48	9.99	.77	.....	1.4	.130
	Jan. 4	1,992	1.027	13.27	3.12	2.97	5.77	.83	.....	2.0	.132
	Jan. 8	2,272	1.029	14.37	2.94	3.20	6.53	.68	.....	.....	.124
299	Jan. 9	1,988	1.031	14.63	8.33	3.35	6.52	.70	.....	4.9	.130
	Jan. 10	1,987	1.031	14.57	3.33	3.28	5.91	.71	.....	5.3	.124
	Feb. 18	8,234	1.031	11.90	3.33	2.59	3.96	.68	28.39	7.4	.128
	Feb. 19	8,519	1.033	12.14	3.57	2.61	3.66	.68	30.83	7.7	.132
	Feb. 20	8,234	1.032	12.33	3.57	2.63	4.07	.68	36.60	7.0	.150
	Mar. 4	8,519	1.031	12.29	3.57	2.72	3.87	.67	29.21	7.2	.154
	Mar. 5	8,945	1.032	11.99	3.57	2.68	3.46	.68	40.63	8.2	.156
	Mar. 6	.....	1.032	12.20	3.57	2.69	3.56	.69	38.25	7.4	.160
	Mar. 8	9,087	1.032	11.98	3.57	2.61	3.25	.69	38.81	7.5	.156
	Mar. 19	4,828	1.029	12.84	3.57	3.01	5.14	.67	27.80	5.8	.108
285	Mar. 20	5,112	1.029	14.60	3.57	3.12	6.73	.67	27.21	5.2	.096
	Mar. 21	5,396	1.029	13.59	3.57	3.03	5.81	.66	22.99	5.1	.098

a Iodine absorption number.

b Number of cubic centimeters, $\frac{N}{10}$ Ba (OH)₂ required for 1 gram of fat.c Number of cubic centimeters, $\frac{N}{10}$ Na OH, required for 1 cubic centimeter of milk.TABLE II.—*Analyses of milk of cows injected with tuberculin.*

183.				189.				222.			
Date.	Quantity.	Specific gravity.	Fat.	Date.	Quantity.	Specific gravity.	Fat.	Date.	Quantity.	Specific gravity.	Fat.
Jan. 14	c. c.			Jan. 14	c. c.			Jan. 14	c. c.		
Jan. 15	4,260	1.028	5.92	Jan. 15	9,655	1.030	4.28	Jan. 15	5,111	1.024	10.87
Jan. 16	4,543	1.030	5.50	Jan. 16	7,950	1.028	4.29	Jan. 16	5,111	1.024	8.20
Jan. 17	4,543	1.030	5.71	Jan. 17	7,983	1.030	3.67	Jan. 16	4,827	1.030	5.09
Jan. 18	4,260	1.029	5.77	Jan. 18	7,667	1.028	4.29	Jan. 17	3,692	1.029	6.53
					7,667	1.027	3.68	Jan. 18	6,247	1.029	6.13
186.				194.				229.			
Jan. 14	.....	.....	.....	Jan. 14	1,420	1.028	10.83	Jan. 14	2,556	1.023	9.03
Jan. 15	375	1.028	5.51	Jan. 15	1,704	1.025	11.06	Jan. 15	5,679	1.022	8.22
Jan. 16	500	1.022	9.04	Jan. 16	1,998	1.029	6.53	Jan. 16	5,111	1.027	4.91
Jan. 17	598	1.022	7.19	Jan. 17	2,272	1.030	6.73	Jan. 17	4,260	1.027	6.95
Jan. 18	440	1.024	6.97	Jan. 18	1,948	1.031	5.09	Jan. 18	6,816	1.029	4.28
187.				195.				234.			
Jan. 14	1,998	1.030	8.77	Jan. 14	5,111	1.024	6.01	Jan. 14	5,111	1.023	8.42
Jan. 15	3,123	1.023	12.32	Jan. 15	1,704	1.027	7.97	Jan. 15	4,543	1.023	6.36
Jan. 16	3,407	1.028	6.13	Jan. 16	2,272	1.029	4.49	Jan. 16	3,692	1.030	2.44
Jan. 17	3,408	1.030	7.54	Jan. 17	1,998	1.028	8.17	Jan. 17	3,975	1.027	7.36
Jan. 18	3,408	1.031	6.16	Jan. 18	2,556	1.030	6.52	Jan. 18	5,111	1.027	5.98

TABLE III.—*Temperature reactions of the cows used in the milk experiments.*

Date.	Time.	No. 299.	No. 161.	No. 145.
1894.				
<i>Before injection.</i>				
December 11	1.00 p. m.	102.3	101.3	101.6
	3.00 p. m.	102.0	98.2	97.3
	5.00 p. m.	101.5	99.4	98.5
<i>After injection.</i>				
December 12 (injected 2 c. c. tuberculin at 8 p. m. December 11) ..	8.00 a. m.	101.0	101.0	101.4
	10.00 a. m.	100.8	101.2	101.0
	12.00 m.	101.2	100.6	102.5
	2.00 p. m.	101.0	102.0	101.2
	4.00 p. m.	101.4	101.0	101.6
1895.				
<i>Before injection.</i>				
January 7	1.00 p. m.	101.0	102.4	100.6
	3.00 p. m.	101.0	102.6	101.2
	5.00 p. m.	101.2	102.7	101.4
<i>After injection.</i>				
January 8 (injected 2 c. c. tuberculin at 8 p. m. January 7)	8.00 a. m.	101.5	101.8	105.2
	10.00 a. m.	101.0	101.7	105.0
	12.00 m.	100.4	100.8	102.6
	2.00 p. m.	101.4	101.0	101.5
	4.00 p. m.	101.3	101.5	101.1
<i>Before injection.</i>				
February 18	9.00 a. m.	101.6	.....	.....
	12.00 m.	100.6	.....	.....
	4.00 p. m.	101.9	.....	.....
	9.00 p. m.	101.2	.....	.....
<i>After injection.</i>				
February 19 (injected 2 c. c. tuberculin at 9 p. m. February 18) ..	8.00 a. m.	101.6	.....	.....
	9.00 a. m.	102.7	.....	.....
	10.00 a. m.	102.6	.....	.....
	11.00 a. m.	100.2	.....	.....
	12.00 m.	100.2	.....	.....
	1.00 p. m.	101.2	.....	.....
	2.00 p. m.	101.5	.....	.....
	3.00 p. m.	101.8	.....	.....
	4.00 p. m.	101.8	.....	.....
	5.00 p. m.	101.4	.....	.....
<i>Before injection.</i>				
March 4	8.30 a. m.	101.2	.....	.....
	12.00 m.	100.2	.....	.....
	4.30 p. m.	101.2	.....	.....
<i>After injection.</i>				
March 5 (injected 30 c. c. tuberculin March 4)	8.00 a. m.	101.5	.....	.....
	9.00 a. m.	102.0	.....	.....
	10.00 a. m.	99.2	.....	.....
	12.00 m.	100.2	.....	.....
	2.00 p. m.	101.2	.....	.....
	4.00 p. m.	101.5	.....	.....
	5.00 p. m.	101.9	.....	.....

TABLE IV.—*Temperature reactions of the cows used in the milk experiments.*

[First test of tuberculous cows.]

Date.	Time.	No. 185.	No. 186.	No. 187.	No. 188.	No. 194.	No. 195.	No. 222.	No. 229.	No. 231.
1894.										
<i>Before injection.</i>										
December 7.....	9.00 p. m.	102.0	100.5	100.2	101.5	101.2	102.5	102.2	101.3	103.9
<i>After injection.</i>										
December 8 (injected 24 c. c. tuberculin 11 p. m. December 7)	8.00 p. m.	102.4	101.2	101.3	102.0	102.0	105.8	102.6	105.4	103.0
	9.00 p. m.	103.1	101.4	100.3	101.8	103.8	107.0	103.6	104.8	103.6
	10.00 p. m.	105.3	103.2	102.4	104.8	104.0	107.2	104.6	103.4	103.8
	11.00 p. m.	105.6	105.6	102.1	105.8	103.8	107.2	108.4	106.2	104.8
	12.00 m.	106.6	106.0	101.5	106.6	104.3	107.4	106.2	106.9	104.5
	2.00 a. m.	106.0	105.6	99.7	106.4	106.1	106.7	106.5	106.5	105.2
	4.00 a. m.	105.4	105.1	104.7	105.6	105.2	105.3	105.0	105.4	105.7
	8.00 a. m.	103.0	106.2	104.8	105.6	102.0	104.2	105.2	104.4	104.7
	10.00 a. m.	101.0	100.5	101.0	100.5	101.0	101.1	101.0	100.4	102.6

[Second test of tuberculous cows.]

1895.										
<i>Before injection.</i>										
January 15	4.00 p. m.	102.2	102.5	101.8	102.8	102.0	101.4	101.4	101.6	100.2
	9.00 p. m.	102.0	101.8	100.8	102.5	101.8	101.8	101.0	101.0	101.4
<i>After injection.</i>										
January 16 (injected 2 c. c. tuberculin 11 p. m. January 15)	8.00 a. m.	101.5	102.0	99.6	102.0	102.6	105.2	104.7	103.2	105.3
	8.30 a. m.	101.8	103.2	101.0	102.0	101.8	105.2	105.2	104.0	105.4
	9.00 a. m.	102.4	103.2	101.2	103.3	102.6	105.2	105.2	104.6	105.4
	9.30 a. m.	102.2	103.5	101.2	103.2	102.8	105.3	105.4	105.4	105.8
	10.00 a. m.	102.2	103.6	101.2	103.4	102.8	105.4	105.3	105.2	106.0
	10.30 a. m.	102.2	103.0	101.6	104.2	103.0	105.2	106.0	105.5	106.0
	11.00 a. m.	102.4	103.2	101.5	104.6	104.2	105.1	106.0	105.6	106.2
	11.30 a. m.	102.6	102.9	101.2	104.2	104.4	105.0	104.6	105.4	106.4
	12.00 m.	103.0	102.8	103.2	104.2	104.4	104.8	105.3	105.6	106.3
	12.30 p. m.	103.6	102.6	103.6	104.6	104.3	104.6	105.5	104.8	100.2
	1.30 p. m.	103.5	103.0	103.9	104.8	104.6	104.5	105.5	105.2	106.0
	2.00 p. m.	103.4	102.0	104.5	104.8	104.6	104.0	104.6	104.6	105.6
	2.30 p. m.	103.6	101.6	104.6	104.4	104.2	104.0	103.4	103.5	105.2
	3.00 p. m.	102.4	100.0	105.0	100.0	102.8	103.4	103.5	102.4	104.6
	3.30 p. m.	101.9	99.5	105.0	99.6	102.4	103.0	103.2	102.5	104.2
	4.00 p. m.	101.6	99.3	104.6	99.4	102.0	103.2	103.2	102.6	104.0
	4.30 p. m.	102.8	99.6	104.5	99.4	102.0	103.0	103.2	102.6	104.2

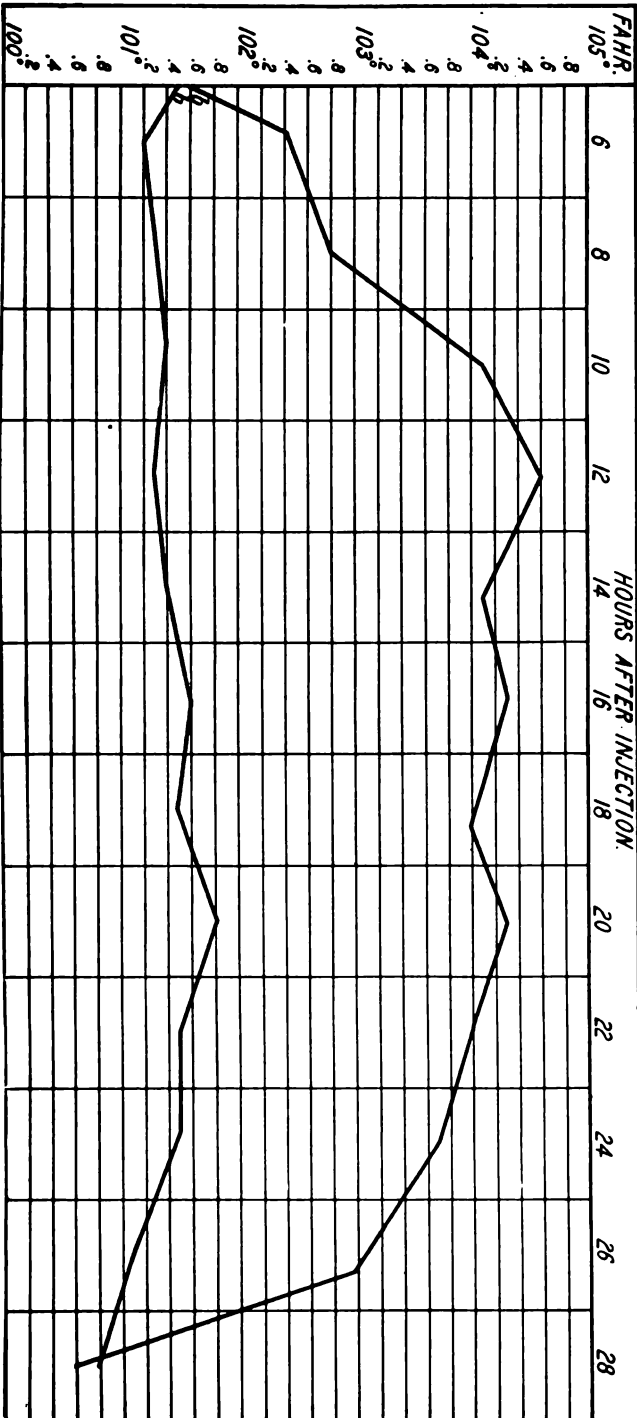


FIG. 1.—Chart showing average temperature of 3,930 healthy and 1,191 diseased cattle injected with tuberculin. (a)

[Average normal temperature of 1,191 tuberculous cattle before injection, 101.6° F. Average normal temperature of 3,930 healthy cattle before injection, 101.5° F.]

a Temperature in February, 1905.

b Temperature at time of injection.

FIG. 2.—Chart showing average temperature reaction of 62 tuberculous and 93 healthy registered Jerseys; 71 tuberculous and 303 healthy grade Jerseys; 38 tuberculous and 155 healthy Jerseys injected with tuberculin. (a)

[Average normal temperature of 231 tuberculous cows before injection, 101.4° F. Average normal temperature of 591 healthy cows before injection, 101.7° F.]

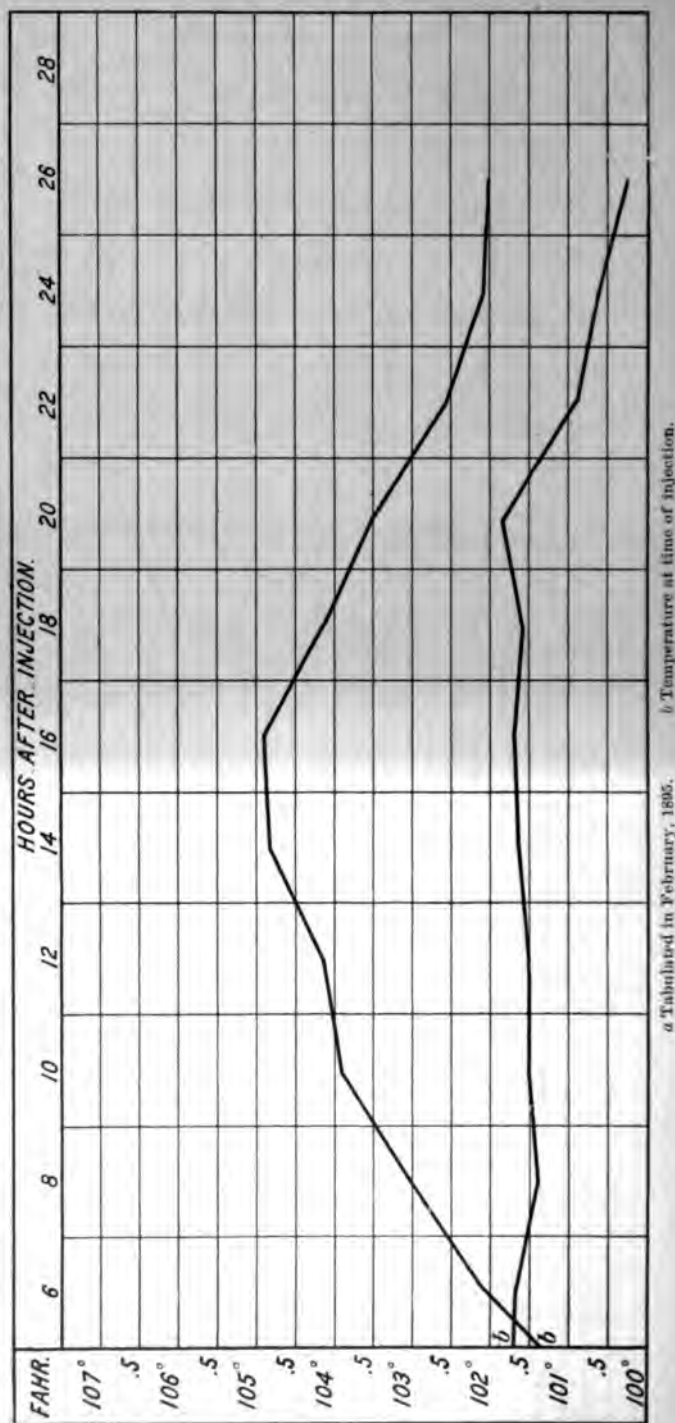
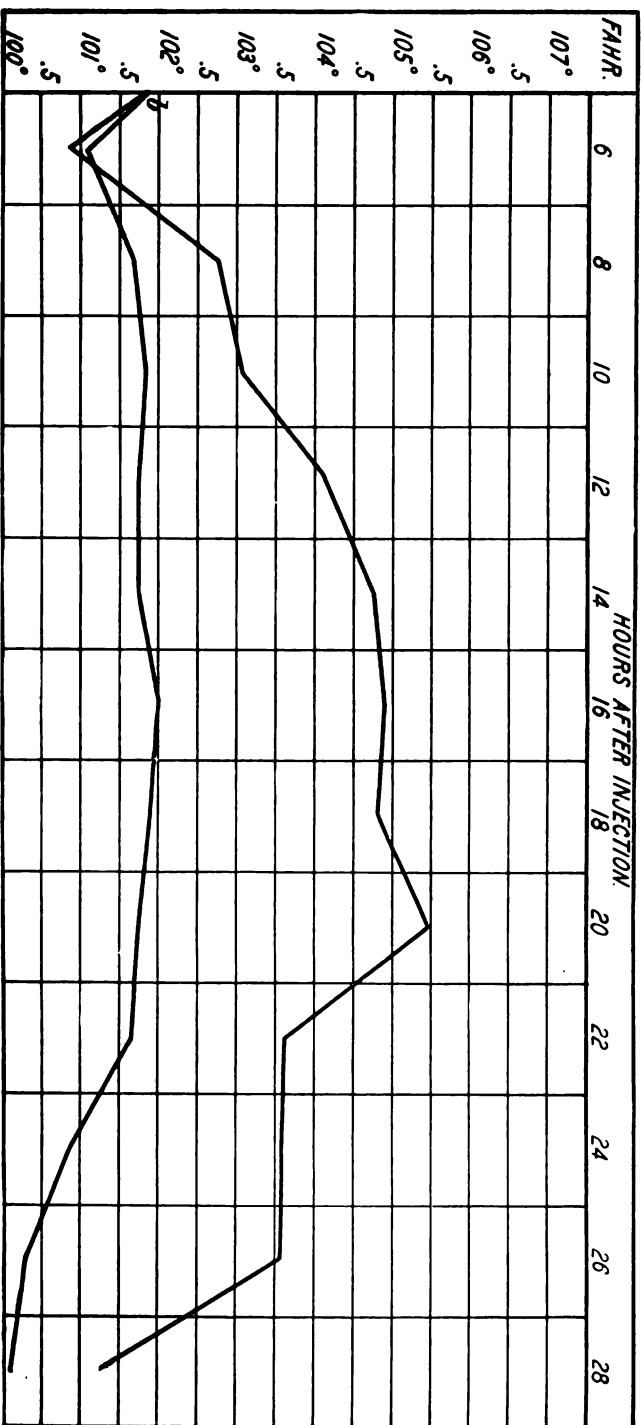


FIG. 3.—*Chart showing average temperature reaction of 40 tuberculous and 68 healthy grade Holsteins; 70 tuberculous and 774 healthy Holsteins injected with tuberculin. (a)*

[Average normal temperature of 110 tuberculous cows before injection, 101.8° F. Average normal temperature of 172 healthy cows before injection, 101.8° F.]

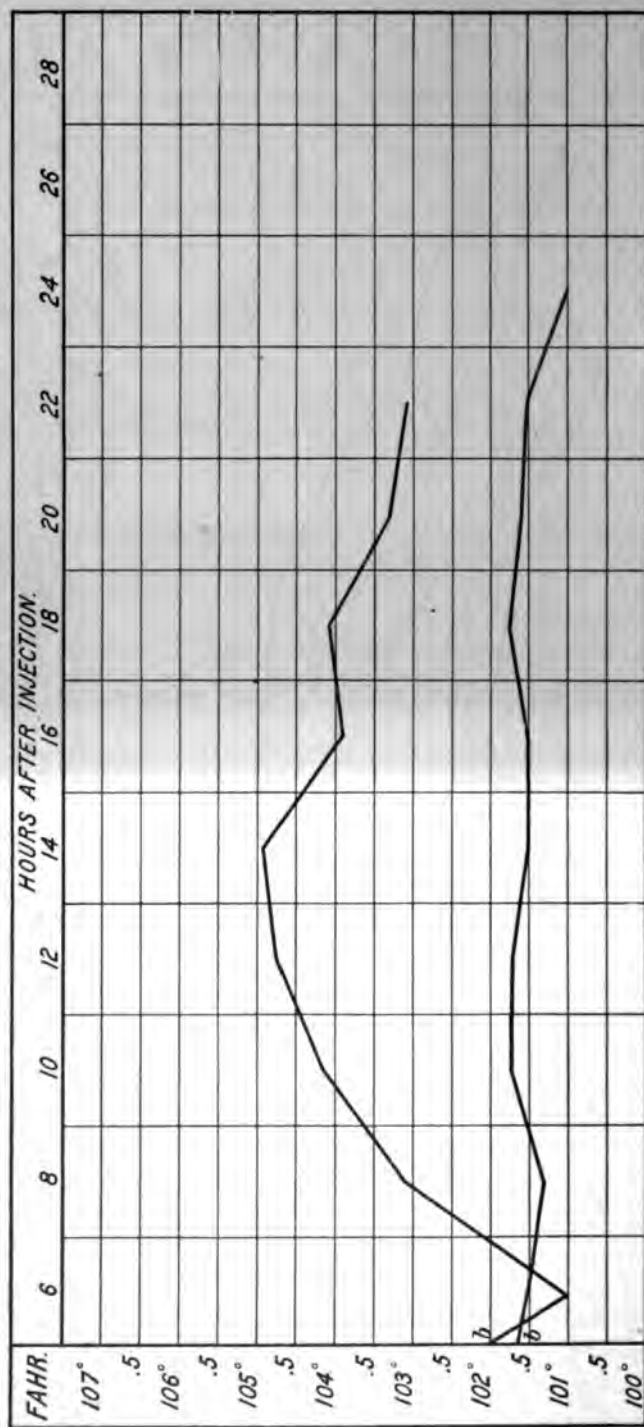


a Tuberculous in February, 1896.

b Temperature at time of injection.

FIG. 4.—Chart showing average temperature reaction of 37 tuberculous and 64 healthy Durhams; 5 tuberculous and 11 healthy grade Durhams injected with tuberculin. (a)

[Average normal temperature of 32 tuberculous cows before injection, 102.1° F. Average normal temperature of 75 healthy cows before injection, 101.6° F.]



a Tabulated in February, 1895.

b Temperature at time of injection.

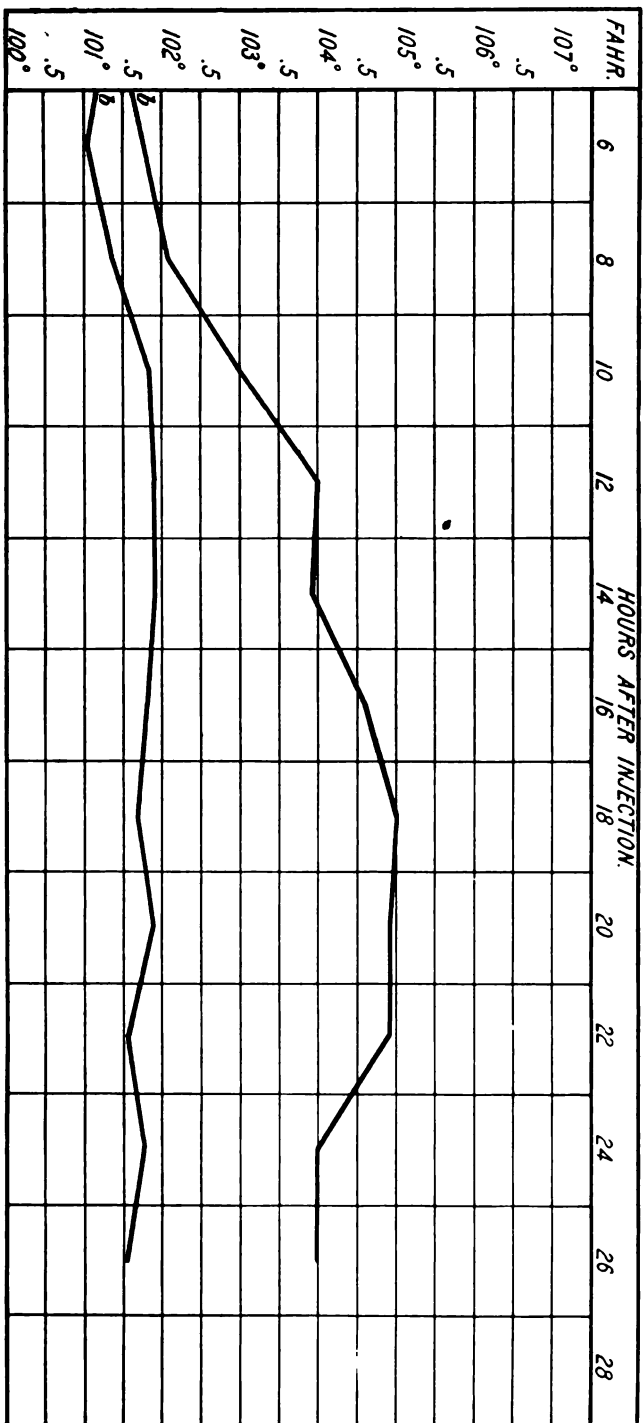
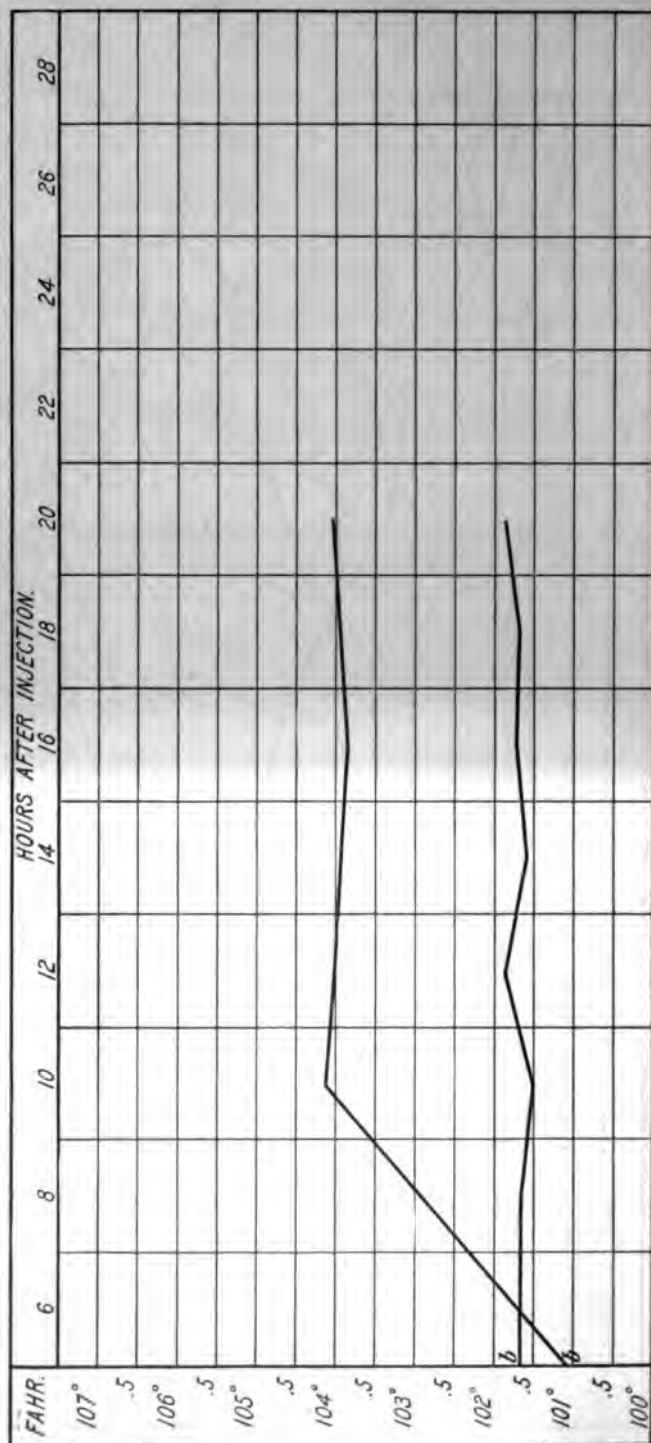


FIG. 5.—Chart showing average temperature reaction of 15 tuberculous and 24 healthy alphas injected with tuberculin. (a) [Average normal temperature of 15 tuberculous cows before injection, 101.69 F. Average normal temperature of 24 healthy cows before injection, 101.22 F.]

FIG. 6.—Chart showing average temperature reaction of 6 tuberculous and 108 healthy Guernseys injected with tuberculin. (a)

[Average normal temperature of 6 tuberculous cows before injection, 101.1° F. Average normal temperature of 108 healthy cows before injection, 101.7° F.]



a Tabulated in February, 1896. b Temperature at time of injection.



FIG. 7.—Chart showing average temperature reaction of 241 tuberculous and 527 healthy grades injected with tuberculin. (a) [Average normal temperature of 241 tuberculous cows before injection 101.8° F. Average normal temperature of 527 healthy cows before injection, 101.5° F.]

a Tabulated in February, 1898. b Temperature at time of injection.

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BULLETIN No. 14.

(Dairy No. 5.)

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.

DAIRYING IN CALIFORNIA.

BY

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Under the direction of
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Chief of the Bureau of Animal Industry.



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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
Washington, D. C., July 15, 1896.

SIR: I have the honor to transmit herewith for publication, as a bulletin of this Bureau, the manuscript of a report, prepared under the direction of Henry E. Alvord, Chief of the Dairy Division, by Prof. E. J. Wickson, special agent of that division, on the history, development, and present condition of the dairy industry in California. The report is of general interest, and contains many suggestions for practical dairymen operating under very diverse conditions.

Very respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

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DAIRYING IN CALIFORNIA.

HISTORICAL.

The grazing interests of California were established by the Franciscan friars who began their missionary effort for the Christianization of the Digger Indians in 1769 at San Diego. In 1697 their predecessors, the Dominicans, located their first mission on the peninsula of Lower California, and a year later brought thither horses and cattle from Mexico. The offspring of this introduction came northward with the Franciscans and were the progenitors of the vast herds which supplied hides and tallow for a large export trade and were the main source of subsistence for a considerable population of mission wards and Mexican settlers previous to the American occupation. Some idea of the extent of this grazing interest can be gained from the fact that in 1834, after the missions had passed the highest period of their prosperity, their property included 424,000 cattle; 62,500 horses, mules, and asses, and 325,000 sheep, swine, and goats. These figures do not include the property of the settlers away from the missions, nor the countless bands of wild cattle and horses which roamed the plains without mark of ownership. But while cattle were thus abundant and labor was to be had for the commanding, there was practically no dairying. The narratives of travelers state that milk was rare, but the poorest settler had plenty of beef in his pot. Even the goats must have been of very low dairy grade, for one visitor, while acknowledging that the goats were milked, adds that it was difficult to get a pint of milk from six of them. The mission padres had plenty of olive oil to take the place of butter, and wine instead of milk. The Mexican settlers, with few exceptions, did not relish the labor which was required to produce wine and oil and therefore drank water until trade brought them stronger substitutes.

With the American occupation, and notably with the inrush of gold-seekers in 1849, a sharp dairy demand arose. This was supplied in great measure by importation, as will be shown presently, but it called into existence local dairying, the development of which was marked by novel features which invite brief description.

ESTABLISHMENT OF THE DAIRY INDUSTRY BY AMERICANS.

The beginnings of California dairying were made in two regions considerably remote from each other—the mining region amid the foothills of the Sierra Nevadas, which form the eastern boundary of the State,

and the seaboard region adjacent to San Francisco, which lies upon our western boundary. The latter region was destined to achieve great commercial importance, but there was no lack of characteristic uniqueness in the former. Many families of gold seekers who took up the march for the California gold fields from their homes on the prairies of the West, camped their way across the plains, subsisting in part upon the milk of the family cows which they drove before them. Reaching the mines, they found that the milk they had been using so freely would command an almost incredible amount of gold from the miners, and while the male members of the family engaged in mining direct, the female members often gained more dust by caring for and selling the product of their cows. Fresh milk and fresh butter brought them immediate and continued prosperity. Favorable lands were selected, and in these mountain homes grew up large herds and finally valuable dairies which formed the nucleus of the mountain dairy district, which will be mentioned in another connection. This pioneer dairy effort was established with cows bred to milk and with the ordinary dairy skill of the eastern half of the country nearly half a century ago.

EARLY PRACTICES AND PRICES IN THE COAST REGION.

The dairy industry of the coast region of the State was established upon a different basis. The early projector had here a wider opportunity in the demands of the thousands who arrived in San Francisco by sea. The supply of dairy goods consisted of butter and cheese by ship around the Horn from Boston and New York, or was gathered up at South American ports, where only the rudest dairying was practiced. These supplies were inferior to begin with, and were rendered almost inedible by the deteriorating influences of long sea voyages. Almost anything in the form of butter and cheese, freshly made, was greedily welcomed. Money was plentiful, and fresh butter commanded \$1.50 and cheese 40 cents per pound. But there were hardships in the way of production, even at these prices. Few cows were to be had except those of the hide-and-tallow breed of the Mexicans. To get any milk at all, this cow had to be lassoed and tied to a stake and allowed the company of her calf before a drop could be secured. Very soon, too, even these unprofitable animals became scarce, because of the vast inroads upon the available beef supply made by the hungry hordes of miners. High beef prices induced the driving westward of large herds of cattle from the Western States and from Texas, and this introduction brought to the pioneer dairyman stock which was poor enough from a dairy point of view, but still vastly better than that of the Mexicans. This movement of cattle soon proceeded beyond local needs for beef and prices ran low, but the inferiority of the stock as dairy producers was clear, from the fact that while the best of the 4-year-olds could be bought for \$10 each, and pasturage was almost free, the price of butter was 38 cents and of cheese 15 cents per pound. But if

the cattle were bad, the dairy practice was a match for them. Nothing better than the roughest sheds were used to shelter the milk and dairy apparatus and to cure the cheese, and the cattle had no shelter whatever. The mild climate made this possible. The products themselves fluctuated in a way almost incredible. As late as 1858 cheese made from skimmed milk and sweet buttermilk combined sold at 25 and 27 cents per pound the same day it was taken from the hoop, and butter brought \$1 a pound. Within two years these prices were quartered and the ruling rates were counted unprofitable, as indeed they were under the conditions then prevailing.

Under these circumstances the poorest dairymen went into other pursuits and the poorest cows to the butcher. Men with some dairy insight pushed forward into better systems of operation, cows were selected and trained for dairy production, pasture lands were purchased or leased in large areas, and the California system of large private ownership of lands and cows, with leaseholds to operating tenants, arose. This system of dairying with leased lands and cows will be described later.

MORE RECENT ASPECTS OF THE INDUSTRY.

During the decade following 1860 dairy operations were greatly extended. There were very wide fluctuations in market values, and there were serious losses of stock from drought, which the dairymen had not yet learned to provide against; but, on the whole, the business was very profitable, although still very wastefully conducted. The extent of the demand can be seen from allusion to importations. From 1860 to 1865 the importation of butter steadily increased, until in the latter year there was more than 6,700,000 pounds imported, for which more than \$2,000,000 was paid. Local production soon began to supplant this importation, but there was about an average of a million pounds of butter brought in by ship each year for several years thereafter. The completion of the overland road also ministered to the supply from distant sources, and during the fall and early winter of each year considerable quantities of oleomargarine and creamery butter from the Chicago region were brought to San Francisco.

Cheese was also largely brought in by ship and rail during the earlier years of California's growth, and, in fact, it was not until about 1878 that local production reached the amount of local needs. From that time to the present there has been a surplus for distant shipment. Until about 1890 this was fairly well disposed of at different places on the coast where new cities were springing up, and where mining, lumbering, and railroad building enterprises were being carried on in advance of dairy development in the immediate localities. At the present time these distant parts of the coast are developing their own dairy resources, and, instead of buying from California, are marketing their surplus so far as possible in California cities. California dairymen have met these changed conditions by the old and accepted dairy weapons, viz, organ-

ization for the improvement of practice and the resulting cheapening and higher quality of the product. Thus the creamery system has come to California sometimes as a graft upon the old system of large private dairies, sometimes as supplementary or as a substitute therefor, as will be presently described.

WIDELY DIVERSE DAIRY CONDITIONS IN CALIFORNIA.

Natural conditions affecting dairy practice in California are widely diverse and necessitate differences in practice in nearly all departments of dairy work, from the selection of forage plants and the care of stock, all the way through the dairy curriculum to the manufacture and care of the product. There is no such variation on the Atlantic Slope; but one can find something analogous in European conditions if he take into account the mountain dairying of the Alpine valleys, the moist, diked lands of Holland, the heated, irrigated plains of Italy, and the coast lands of Normandy, with their perennial pastures born of equable temperature, abundant rains, and fog. Close resemblances to all these various conditions can be found within the boundaries of California, and they must be taken into account in any successful attempt to describe the geographical features of the dairy industry in this State. With this fact in view, it is possible to lay down four chief divisions of California dairy lands, based upon a similarity of natural conditions within each of them. These divisions or regions do not comprise compact geographical areas, but are rather long, narrow bands or belts taking an extended range from north to south, with comparatively short east and west extensions. The governing factors, in their demarcation, are: Proximity to the coast, elevation and local topography, rainfall, and other climatic features. The intrusion of some of these factors makes it impossible to follow exactly geographical lines in defining the regions. For ordinary uses, however, they may be arranged as follows: (1) Upper coast, (2) lower coast, (3) interior valley, (4) mountain valley.

FOUR MAIN DIVISIONS OF CALIFORNIA DAIRY LANDS AND CLIMATES.

(1) The upper coast region comprises the counties north of San Francisco which lie west of the Coast Range Mountains and have a salt-water frontage either upon the Pacific or the Bay of San Francisco, or upon both. These are the counties of Marin, Sonoma, Mendocino, Humboldt, and Del Norte on the ocean, and Contra Costa, Solano, and Napa counties on the bay. In the ocean-side counties the dairy is a leading interest, while in the bay counties it is subsidiary. This region is the oldest dairy district in the State, and it is still in the lead both in extent of production and in the employment of progressive methods. The natural conditions for dairying are unsurpassed. The length of the rainy season gives a natural pasturage longer than can be found elsewhere in the State, and the amount of rainfall is such that there never has been a serious drought.

Extreme length	770 miles.
Length of coast line.....	1,097 geographical miles.
Length of coast line.....	1,280 statute miles.
Breadth, narrowest part	150 miles.
Breadth, widest part.....	330 miles.
Contains	156,592 square miles.

On the immediate coast summer fogs refresh the pastures and ocean influences prevent extreme temperatures at any season of the year. Water is, as a rule, abundant and pure, and the soils exceedingly productive of clovers and grasses as well as of cultivated crops for supplementary feeding.

(2) The lower coast region is usually taken to include all the lands on or near the coast from San Francisco southward to San Diego, a distance of, approximately, 500 miles. This region also lies west of the Coast Range—that is, between the main chain of the Coast Range and the ocean—and is therefore subject to ocean influences in varying degrees, increased by proximity to the shore or lessened by distance or by the intervention of ranges of hills, which act as barriers to the progress of ocean winds and fogs. In this extended region the annual rainfall decreases as you go southward at the rate of about $2\frac{1}{2}$ inches to each 100 miles of distance, and the average temperature increases about 1 degree for each 100 miles. This variation is regulated by local topography to a certain extent, but the general change is as noted. Naturally the northern half of this region is the greater in dairy production. The counties of San Mateo, Santa Cruz, Monterey, San Luis Obispo, and the northern half of Santa Barbara have the dairy as a leading industry, with San Luis Obispo at the front. In favorable years this county has made a record as the banner butter county of the State. Also included in this dairy region are the counties of Alameda and Santa Clara, bordering on the Bay of San Francisco, but within their boundaries horticultural production far exceeds the dairy. The same is true of the southern half of Santa Barbara, Ventura, and San Diego counties, while Los Angeles and Orange counties, by virtue of large areas of low, moist land adjacent to the ocean, market a very large dairy product in addition to a large output of fruits and grains from higher lands. Though this coast dairy region south of San Francisco is thus seen to be notable in its adaptation and development in dairy lines, it is inferior to the coast region north of San Francisco, because of its less moisture and greater heat, its shorter pasturage season, its liability to occasional droughts, which about once in a decade have caused serious loss of stock as well as product, and the need of greater effort to produce supplies of supplementary feeds; and yet through the introduction of better system and wiser foresight in dairy operations these difficulties and dangers give infinitely less concern than they did in former years.

(3) The interior valley dairy region comprises lands removed from coast influences. They are situated on the east side of high elevations of the Coast Range, which largely exclude ocean winds and fogs, including all the counties lying in the valleys of the San Joaquin and the Sacramento rivers and their tributaries. These areas comprise one great valley between the foothills of the Sierra Nevada on the east and the Coast Range on the west. It is, approximately, 400 miles long and varies in width from 40 to 60 miles. The valley region also

includes some areas in southern California at a distance from the coast, but owing to the eastward trend of the high Coast Range in southern California conditions are not quite the same. Here and there gaps in these mountains open a path eastward for ocean temperatures and moisture and give to adjacent lowlands a mixture of coast and valley conditions, so that one region intrudes upon the territory of the other. This is notable where the Sacramento and San Joaquin rivers break through the Coast Range to reach San Francisco Bay and where the Salinas and Pajaro rivers flow into Monterey Bay. At these points ocean influences extend far into the interior, being, however, progressively ameliorated by interior heat and drought, as they proceed. The valley region proper does not include these modified areas, and is distinctly free from coast influences except those which surmount the ranges and thus have an effect upon the climate of the whole State. The leading characteristics of the interior valleys are high summer heat and very dry summer air; very small and uncertain rainfall, consequently frequent and severe droughts; a very short season of succulent pasturage, except on irrigated or low, moist river-bottom lands of comparatively small area; scant water supply and that of undesirable warmth; occasional presence of insects in grievous numbers. In short, in their natural conditions these interior valleys are unfitted for dairy husbandry except during the winter, when, if the rainfall be adequate, there is a very free growth of rich pasturage and the temperature conditions are excellent for dairy work.

In these arid lands progressive dairying has made its greatest achievements. The introduction of irrigation and the growth of alfalfa and other plants impossible without it; the use of centrifugal separators to secure the cream which could not be raised in good condition by the gravity method because no refrigerating agency could be had cheaply enough for general use; the construction of buildings excluding high temperatures and the employment of devices for cooling by evaporation of moisture—in fact, by meeting unfavorable conditions at all points by ingenuity and the employment of the latest dairy inventions, dairy manufacturing in the interior of California has been made practicable and profitable, and many lessons can be learned from it for the guidance of practice in other heated, arid regions. As a matter of recent history, it may be added that these interior regions, which were once almost wholly dependent upon the coast and the mountains for their dairy supplies, are now producing for distant shipment.

In all the interior valley region, however, both north and south, differences are in degree rather than in kind, and in all of them the use of naturally moist or irrigated land and advanced dairy practice are the ruling factors of success. Although this region is of vast area, only a small fraction is as yet employed in dairying. Fruit and grain are the chief products, but the dairy would increase as the irrigated area is extended if adequate market demand were assured. At present this does not seem to be the case.

(4) The mountain valley dairy region of California is quite distinct in its characteristics from any of those already mentioned, and it approaches more nearly than any of them to a likeness to the dairy conditions and practice of the Eastern States. In one sense the mountain region is supplementary to the interior valley region, because there began very early in the development of the State an itinerant system of dairying in which the cows were driven back and forth from valley plains to mountain meadows, wintering in the valley and summering in the mountains. This practice chiefly prevailed in the northeast quarter of the State, and while uninclosed public lands yielded abundant free pasturage and prices were high, it was very profitable. As a system it was quite analogous to the Alpine dairying of Switzerland. More recently the occupation of public lands and other adverse conditions have reduced the practice, but some dairymen have permanent locations both below and above, and still migrate twice a year. The system does not favor the use of improved methods and can not long survive.

This is, however, only one phase of mountain dairying, and now the least important one. The early demonstration of the good points of the mountain district was followed by the permanent establishment of dairying. The natural pasturage is superior, and moisture in summer favors the growth of some standard dairy grasses which do not thrive elsewhere in California; the streams and springs run cold water; natural ice can be had, and deep setting in coolers is feasible.

On the other hand, a winter of snow and ice makes the Eastern methods of stock shelter and provender imperative, and distance from market and wagon transportation of products place the producer at something of a disadvantage. While good dairy markets in the mining towns of Nevada could be had, this was not of so much importance, but now that these towns have declined and Nevada has become a shipper of dairy produce to California markets the situation of the mountain dairymen is less satisfactory. The mountain region is, however, one of great reserve force, and in the future growth of the coast will have better opportunity to exercise its excellent productive ability and to use its rich resources. The mountain counties which have made the best records in mountain dairying are Sierra and Plumas, although other counties both north and south of them also have important dairy interests and resources. Siskiyou and Shasta counties have thriving local dairy establishments which find a market in adjacent mining regions. Lassen and Modoc counties have large grazing and grain interests, and with better transportation facilities could largely increase their dairying. The higher elevations of Placer, Nevada, Eldorado, and, in a less degree, Amador and Alpine, have good mountain pastures which are partially utilized, while Mono and Inyo, the only counties in California east of the Sierra Nevada Mountains, have a considerable surplus dairy product which reaches market by means of a railway running thence into Nevada.

THE LEADING DAIRY COUNTY OF CALIFORNIA.

The foregoing sketch of the dairy regions of California includes mention of the counties which lead in this industry. The greatest of all the counties in amount of product, in number of modern establishments, and first in the construction of a modern creamery, is Humboldt County, with a butter product of 2,843,452 pounds in 1892. Although the county has other very important interests, it is the estimate of several well-informed persons that over one-half the population is concerned in dairying, and in some parts of the county quite three-fourths of the people are thus engaged. Probably Humboldt, and Marin in a less degree, are the only counties in which such high percentages rule, but there are parts of other counties in which similar proportions could be given. California has always been marked by local specialization of products. This is to some degree a rational deduction from clearly discerned differentiation in local climates, and in some degree attributable to popular conceptions of greatness in farming policy. It was a very early notion in California that the farming operations of an individual must necessarily cover a vast area of land. It was easy to acquire such areas in early days, and the influence of such acquisitions and of farming methods required by them is still strong, though its departure can now be clearly foreseen. Aside from this, however, there is good reason for much specialization, because conditions change so greatly. On the moist lands of Orange County, for instance, probably about one-third of the people are engaged in dairying, while on the adjacent higher lands there is not only little dairying but probably many of the fruit-growers who use those lands do not even keep family cows.

CALIFORNIA SYSTEM OF LARGE DAIRY HOLDINGS.

The size of the dairy farms and the number of cows to each vary within wide limits. As stated, the old plan was to have very large herds and farms; but the old plan was also to have rather small dairy buildings and enough of them. They were so located that part of the cows could be conveniently driven to each for milking, and a butter or cheese maker was located at each of these branch establishments. As each of these branches must have its own foreman and cook, as well as its own gang of milkers, it was soon seen that a system of tenantry would both relieve the owner and inspire the foreman to watchfulness and zeal. It would also be economical to have the foreman's wife for cook. The result was that a lease price was put upon the branch at so much per cow furnished by the owner, the lessee to furnish his own labor, force, and utensils, and to raise an agreed number of calves each year for the owner; the owner to keep up the number of good cows and to furnish materials for necessary fencing and buildings, for the construction of which the tenant supplied the labor. The tenant paid a cash rent; consequently the produce of the dairy and the swine yard belonged

to him, and there was no division of products to worry about. While dairy prices were good this arrangement was mutually satisfactory to owner and lessee, and with a good large herd of cows the latter was able to secure an income which enabled him to hire all the labor necessary to maintain his family in good style and have a comfortable bank account, which allowed the purchase of good appliances, etc. In this way the system of large single dairies came about in California. Some tenants handled as many as 300 cows and manufactured as much milk as the smaller cooperative establishments at the East received from their patrons. The lease rate per cow naturally declined with the coming of lower values for dairy produce from the old range of \$25 to \$30 to the present rate of \$16 to \$20. The tenants' net income declined even more notably. The result has been that many American tenants have saved themselves by introducing creamery outfits, while others gave way to Europeans, who could live on narrower margins and were able to secure labor of their own nationality for less than the former tenants paid. Some of these European dairymen are very bright and enterprising men, and now figure as large dairy proprietors and leaders in the commercial as well as the producing branches of the industry; others are very ignorant and too often squalid, and form a decided barrier to local dairy progress.

Although large dairy holdings still prevail in the older regions, there has been, during the last twenty years, great increase in the number of small dairy farms, and this has been due in part to the subdivision and sale of the old holdings and in part to the advance of the interest into newer parts of the State. The present range of herd numbers of creamery patrons in several counties is as follows:

County.	Average number of cows to the farm.
Siskiyou	30
Humboldt	40
Mendocino	25
San Luis Obispo	75
Santa Barbara	100
Los Angeles, Orange, and San Bernardino	12

CAPACITY OF CALIFORNIA DAIRY LANDS.

The number of acres required for the keeping of a cow in California is determined by local conditions of soil and climate. There are cases in which 1 acre to the cow can be cited, and others in which 2 and even 3 acres are allotted to the cow in estimating the capacity of pasturage. Beyond this there are pastures so scanty that the growth on 5 acres will not exceed the wants of a single animal. The best records are made in the moist, rich, coast valleys of Humboldt County and on the alfalfa lands in the irrigated or the naturally moist sections of the interior valley. Two instances are given by correspondents in Eel River Valley, Humboldt County, viz: Mr. A. Kansen, of Ferndale, keeps 35

cows on 34 acres, secures an average yield of 300 pounds of butter and buys no feed whatever. The cows are on pasture nine months of the year, and for the other three they are fed hay and roots, all grown on the 34 acres. J. E. Brown, also of Ferndale, keeps 35 cows on 40 acres, his average yield and feeding being like the preceding. These records are strictly credible when one knows the natural pasturage conditions prevailing and the favoring climate. The cows are simply good selected grades of dairy breeds. The average in the dairy sections of Humboldt County, that is, on the best of the valley lands, is $1\frac{1}{2}$ acres to a cow.

THE DAIRY BREEDS IN CALIFORNIA.

Although all the leading dairy breeds have secured introduction to California, only three have made a wide and enduring impression on the ordinary run of dairy cattle. They are, both in historical order and extent of influence, as follows: The Shorthorn, the Jersey, and the Holstein-Friesian. The Ayrshire, the Devon, the Guernsey, and others only show their impress in localities adjacent to the few imported herds; they have never taken widely. On the other hand, one can hardly go into the dairy regions anywhere without being able to recognize the marks of the three breeds first named. The Shorthorn gave the first great improvement on the common stock, which was, as already stated, of mixed Mexican and American origin. The breeding of dairy families of Shorthorns has continued with due enterprise and care, and sires of such parentage have always been in request. The Jerseys next secured wide introduction on the basis of cream and butter points, and the Jersey cross became very popular and is still largely used. Then came the Holstein-Friesians, with their great milk yield, and many dairymen, who desired to correct the tendency to decreased size resulting from the Jersey cross, used the black-and-white stock to increase size and capacity. This comment fairly represents the popular conception among dairymen of the relations of these three breeds. We have, of course, individuals who adhere strongly to continuous use of sires of the same breed, and others who rely upon continuous selection from dairy stock of uncertain ancestry. On the whole, the dairy stock of the State is of very good quality and capacity.

DRY FEED AND ITS CHARACTERISTICS.

In the descriptions of the dairy regions of California previously given, there are references to the different lengths of the natural pasturage season in each. Those remarks apply to the natural growth of succulent pasturage. Besides this, there is in California what is locally known as "dry feed," which is quite an important factor in all branches of our live-stock husbandry. This dry feed is simply the growth of grasses and clovers which have naturally matured by the advancing drought of the summer season, and constitute, therefore, an unmown hay on which

the animals subsist. It will occur to the distant reader that it would be better to cut and stack this hay when it is in its best condition than to allow it to desiccate in the sun and wind. Of course, when such wild growth is in suitable quantity on lands convenient to mow, this course is often taken nowadays, but the growth on hillsides or in canyons and the aftermath of low-growing grasses and clovers would cost more than it would yield in the mowing, and much of it, like the rich seed pods of the bur clover (*Medicago denticulata*) and other short growth of leaf and seed, could not be secured by any machinery except the oral outfit of the grazing animal. Besides this, dried herbage is richer in nutritive materials than a stranger might think, because its maturity is forced upon it by the heat and drought, and it retains such richness in its dried fibers that it is not at all to be compared with the dead grasses of humid climates. The most obvious demonstration of this fact is the sight of cattle, sleek and fat, on brown fields, apparently, too, as bare as they are brown, gaining full nourishment from the rubbish-like seeds and dry herbage spread over the sun-baked soil.

PASTURAGE SEASONS IN CALIFORNIA.

Speaking generally, the growth of grass in all parts of California, except the mountain region, begins with the fall rains. These rains come from the north and occur first in the upper coast region and then in the northern half of the interior valley region. The mean date for this opening of the growing season in northern California is October 8. Later the lower coast region is reached, and after that the southern half of the interior valley region, the mean date being November 1 for the southern half of the State. The ideal, or as common parlance goes, the "good year" is one in which the rains occur at short intervals, so that continuous pasture growth is maintained after the naturally sown seeds are once germinated. In such a year the cattle are wading knee-deep in succulent vegetation from January until May. The landscape is carpeted with the varied hues of wild flowers, the cattle are sleek, and the flow of milk is forced by agreeable temperatures and a wealth of juicy forage. Except on pastures heavily overstocked there comes after the rains are over a good amount of dry feed, already described, and the scattering of enough seed to insure a good start of plants at the coming of the following fall rains.

This is the "good year" during which the stock find abundant feed in the field for the full twelve months, and it is this good year which is to be credited with both the fullness and the lack in California dairying. The good year does not always come, and the modifications of it are sometimes trying. The rains, which sometimes come too early, may be followed by two months of drought; they have given moisture enough to spoil the dry feed and to start the seeds of the new growth which the drought destroys. This time the fields are really bare and yield no forage, and the dairyman having learned to trust in a good

year, has to risk this year's profit by buying feed which he ought to have grown, and would have grown if he had not indulged the illusion that he would not need it. In his dairy economy he has planned to have his milk flow come with the new grass, and his cows shrink because, instead of full pasturage, they are given a scant ration of hay, which is doled out because the backwardness of the pastures has induced an unusual demand and a consequent advance in the price of hay.

Again, perhaps the season may depart from the ideal because of excessive rains and cold, driving storms in which his cattle suffer from exposure for lack of shelter, which the counting on a good year has convinced him was unnecessary. Again, there may be a departure in the shape of unusual succession of frosts and possibly a snow flurry, and then the cattle suffer both from scant growth of herbage and lack of shelter. It is because of this too great trust in California skies and winter fields that the old style of open-air dairying is often disappointing. It is a mark of the present progressive dairying to provide extra feed and shelter and good dairy buildings generally, because they are a surety against loss, although they may not always be required.

THE MILKING SEASON AND WINTER FEED.

These statements are necessary to an understanding of the length of our pasturage season and the vicissitudes which attend it. The length of the milking season will average about nine months; in many of the better herds it is ten months, and that is about the period which is aimed at by others who do not quite attain it. On the other hand, in some of the remote counties, the cows divide their time about equally between resting and milking. In such cases the cows have to "rustle" for feed and shelter during the winter, and are milked only during the grass season of the higher altitudes.

In all except the mountain region the length of the pasturage season is about nine months; and though usually the cattle are kept afield the whole twelve months, for about three months they are given some supplementary feed. In dairies adjacent to San Francisco and Los Angeles, and here and there elsewhere, there are dairymen who find it profitable to follow modern methods in using rations of various purchased feed-stuffs in connection with hay and pasturage, but over the greater part of our dairy area the cows have only what the ranch produces. In the alfalfa districts they have alfalfa pasturage in summer and alfalfa hay in winter, for this plant does not make a good winter growth, though in the same regions there is often a growth of salt grass, which adds succulence to their hay ration. In the coast regions, where alfalfa does not find the heat it desires, dependence is placed upon hay of the wild, winter growths, or of barley or wheat cut before ripening. In Humboldt and Del Norte counties, as well as along the moist river lands of the central part of the State, there is a growth of the common

red clover (*Trifolium repens*), which yields a heavy cut of hay; but this plant dislikes the drought of other parts of the State. Nearly everywhere, on the moister or irrigated lands, very heavy crops of roots and marrowfat squashes are grown in the summer for late fall and winter feeding, and the climate is such that these products need no storage, but are fed right from the field whenever they are needed.

SUCCULENT FOOD DURING THE SUMMER DROUGHT.

It has been shown above that in our best years very little winter feeding is necessary, and even then only for a short period. The time when extra feeding is most desirable to maintain the flow of milk is in the late summer and fall. Some dairymen plan to have this their closed season, and with the cows coming in fresh in the fall, about the time when the new grass should put in its appearance, they practice winter dairying with fresh pasturage, which would seem to be a very natural arrangement for this climate. But even with this arrangement, or without it, it is exceedingly desirable to maintain the flow as late into the summer or fall as it can be profitably done. This is the season of "dry feed," previously mentioned, and even if such feed be abundant and rich, as described already, its lack of succulence checks the milk flow, and it gives the product something of the character of the Eastern winter butter. It is to maintain the character of grass products, as well as to increase the quantity of them, that much effort is made in those sections where the pastures dry up early. Available moist land is made to grow fodder corn or sorghum, which does vastly better in the hot, dry air of the interior than roots and squashes and other crops which furnish succulence in a time of drought. It is for this part of the year, and not for winter, that the silo is now being used by some dairymen, both North and South, and it is probable that it will be used more generally in the future than it has been in the past. To preserve for autumn the succulence of spring growth seems to be its chief function in California. At this time of the year, too, there is now becoming available considerable quantities of pulp from the sugar-beet factories, and this is also being siloed for winter use when necessary.

THE BEST DROUGHT-RESISTING FORAGE PLANTS.

For the improvement of California pastures it has long been seen that drought-resisting grasses and forage plants are very desirable. The great mass of the natural growth, and the chief of the introduced plants which found their way in at some remote period, are annuals. As soon as overstocking reaches the prevention of self-seeding, the pastures decline. For years the cry has been for perennial plants which would hold life in the root, and continual effort has been made in this direction by the California Experiment Station and by enterprising individuals. Our greatest acquisition has unquestionably been

alfalfa, but alfalfa does not endure hard, dry soil; it requires depth and permeability and moisture within reach of its roots, and heat greater than some of our coast regions afford, to do its best. Of all the introductions of the last quarter of a century the best can be quickly named. They are perennial rye grass, especially from seed which comes to us after acclimation in Australia, and is locally known as "Australian rye grass;" orchard grass; meadow soft grass (*Holcus lanatus*), locally called "mesquite;" Texas blue grass (*Poa arachnifera*); tall oat grass (*Arrhenatherum avenaceum*); Schrader's brome grass (*Bromus unioloides*), and Hungarian brome grass (*Bromus inermis*). These grasses make a good winter growth, and being once well-established maintain life in the root through the dry season, not only furnishing moderately succulent forage during the dry season, but starting into active growth with the first fall rains. They will not do this in our very driest lands, but they will hold on in regions fit for dairying. They are coarse grasses compared with the choice summer grasses of humid regions, but, under the circumstances, they serve a very good purpose.

It is the spontaneous growth during our rainy season which should be compared with the summer growth of humid regions. This growth includes a large number of native species of grasses and clovers, different groups of species prevailing in the different parts of the State. Two foreign plants introduced in remote times also notably contribute to our winter pasture. They are the bur clover (*Medicago denticulata*), already mentioned, and alfilerilla (*Erodium cicutarium*). They cover the ground with a mat of the most tender herbage after the earliest fall rains, and respond with freedom of growth proportionate to the abundance of the winter rains, often yielding a good cut of hay in some parts of the State.

WINTER SHELTER IN CALIFORNIA.

Some hints of the winter care of our dairy stock have already been given in connection with the discussion of pasture. It should, however, be plainly stated that our winter or rainy season climate is so mild that it is possible to conduct a dairy without any shelter whatever for the cattle, and probably three-fourths of our cows have none. They pass the days and nights on the pasture ranges and are gathered into paddocks or "corrals" twice a day for milking. While it is possible to do this it is clearly not desirable, and though it saves the cost of sheds or barns, it is evident from the experience of those who follow a better system that the increased yield and better quality of product from cows which have shelter, when shelter is desirable, more than pay good interest upon the investment required to provide buildings. Cows which are compelled to stand through chilly and sometimes protracted storms can not do their full duty at the pail. Food has to go to maintain living temperatures in the body during such stress of weather.

Although our winter temperature, in all except the mountain region, rarely falls below freezing, the drenching of cold rains is still a severe tax upon animal endurance. Besides, milking in the open air during such storms is bad for the cows, bad for the milkers, and especially bad for the milk. Milking in the rain carries much of the hide-wash into the pail, and where the corral is floored with soft mud and manure so that the udder is befouled, it is next to impossible to get clean milk. California dairying is often condemned for such practice, and it should be, but in current comment the occurrence of the evil is often exaggerated. The contamination of the milk by corral dust in the summer is also a constant danger. It requires the greatest effort to avoid filth in open-air dairying. To accomplish this and for the benefit of the cows, and the comfort of the milkers, there has been a notable increase during the last few years in the number of barns and sheds on our dairy farms, and some adopt the practice of always milking under cover and of retaining the cows in the stanchions during heavy storms, and at least one establishment, that of D. D. Wilder, of Santa Cruz, not only has fine cow barns, but lights them and the adjacent corrals with electric lights. The conclusions of the most thoughtful dairymen on this subject are outlined well by Mr. James Boyce, manager of the Diamond Springs Creamery, Humboldt County, in these words:

Cows are stabled at night about thirty-five to forty nights in the year and fed hay and roots. In some localities no barns are used; cows are milked in open corrals, and only get the grass that grows. But cows do better when sheltered from the rain and fed in warm barns during the rainy season of each year.

The importance of this matter is of course greater in regions of heavy and protracted rain storms and tenacious soils. In parts of the State where there is a light rainfall and sandy soils, the open-air system is less objectionable, but even in such places there are those who believe in good buildings and generous feeding in addition to pasturage. In the mountain region good dairy barns and ample winter food are provided as the wintry conditions require them.

WATERING DAIRY STOCK.

The water supply has been suggested in the foregoing descriptions of the dairy regions. Wherever perennial flowing streams exist they are fully drawn upon. Over a much greater area of the State, however, dependence is placed upon wells and windmills or upon flowing artesian wells, and in some cases upon water from irrigation ditches. This water is always of moderate temperature and no special methods of watering stock are employed.

MONTHS OF GREATEST PRODUCTION AND THE YIELD PER COW.

The months of greatest milk production in the southern half of the State, and in the interior, both north and south, are April and May. In the coast region north of San Francisco, owing to the later season

of green grass, the two best months are May and June. But all the months from March to July, inclusive, give a good milk yield, and by due effort for feed and seasonable calving the dairy is run at considerable capacity the whole year. Except in the mountain region, many creameries are operated the whole twelve months.

The estimates of a satisfactory yearly product for an average cow, furnished by a large number of dairymen, vary widely. One correspondent places it as low as 150 pounds of butter and several cite 300 pounds. From 200 to 250 pounds of butter in a year is the range mentioned by most correspondents. Though there are bands of 30 to 80 cows reported from Humboldt County as ranging from 275 to 325 pounds of butter yearly, it is plain that such dairies are above the average, both in breeding and selection, or in feeding, or in both.

NUMBER OF CREAMERIES IN CALIFORNIA.

It is exceedingly difficult to state exactly the number of the manufacturing establishments which should be called creameries or butter factories in distinction from private dairies. This is due to the system of large dairy proprietorship in this State to which allusion has already been made. If we should call that alone a creamery which handles the milk of several producers, we should give creamery honors to some establishments which are smaller in cost and in production and less thoroughly equipped than other establishments which handle the milk of a single owner or renter of cows. As a matter of fact, the term "creamery" has often come, in this State at least, to signify any concern, however owned or managed, which is equipped with power, centrifugal separators, and the other concomitants of modern dairy practice.

As prices for dairy produce have declined to a level very near the actual cost of production, even by means of the best appliances and the most economical processes, there has been during the last few years a very general disposition to follow creamery practices as the only means of survival. The result has been a remodeling of the large private dairies as well as the organization of cooperative creameries. The largest and most successful creameries are situated in the coast regions both north and south of San Francisco. Occasionally one of these has proved illy placed or badly planned and defectively furnished, for dishonest and slipshod work in dairy building and equipment have been experienced here as elsewhere. We have also suffered to some extent from the nefarious efforts of the creamery "boomer," or promoter, and creameries have been constructed where there are no cows. Of these the buildings have been put to other uses and the machinery set aside or sold at a sacrifice.

By the closest computation that can be made, the number of establishments which are operating upon the creamery plan in California in 1896 is 300. Of these, 100 are creameries, receiving the milk from a number of patrons, and 200 are private dairies with power separators

and other creamery adjuncts. These "private creameries" average about 150 cows each, with some of them having as high as 400 cows. The cooperative creameries range in cows from 250 to 4,000, with an average of 500 cows. Of these establishments about one-half are proprietary and the other half about equally divided between joint-stock and cooperative. All sorts of opinions are given by correspondents as to the comparative advantages of the different kinds of ownership. The joint-stock plan, if most of the stock is owned by the farmers of the neighborhood, seems to be most generally approved.

WIDE USE OF CENTRIFUGAL SEPARATORS.

All the creameries of California are conducted upon the separator plan. As previously stated in connection with the description of the dairy regions, the absence of natural ice and cool water in all save the mountain region renders all deep-setting devices impracticable, though refrigerating machines are being introduced for creamery use. The only issue then is that between the separator and the shallow pan, and the separator is the *sine qua non* in our creameries and is rapidly pushing out the pans in the smaller dairies as well. All the prominent patterns of separators are in use. The largest creamery in California is the establishment of the Guadalupe Creamery Company (cooperative), located at Guadalupe, on the coast, in the north-west corner of Santa Barbara County. It has capacity for the milk of nearly 4,000 cows, and is in a region of very large dairy holdings. It has one skimming station and uses altogether six separators, mostly of the Alpha De Laval pattern, and has received at times 60,000 pounds of milk per day. A very good representative report is that furnished by the Diamond Springs, at Swauger, in Humboldt County. In 1895 it received milk every day in the year, recording a total of 5,523,000 pounds of milk, from which there were made 263,000 pounds of butter; and 500 hogs, of from 100 to 200 pounds weight each, were grown upon the skim milk. This creamery paid out to 41 patrons the sum of \$50,000 during the year. The largest amount of milk received in a single day was 40,000 pounds. This milk was handled with four separators. Other reports are as follows: Union Creamery, San Luis Obispo County, 20,000 pounds per day, two Alpha De Laval separators; in Eel River Valley, Humboldt County, five creameries of about equal size use four separators each, mostly Alpha De Laval; Scott Valley Creamery, Siskiyou County, 12,000 pounds, two Sharples separators; San Bernardino Creamery Association, 10,000 pounds per day, one Jumbo; Norwalk, Los Angeles County, 16,000 pounds, Alpha De Laval; Westminster Butter and Cheese Company, Orange County, 10,000 pounds per day (including two skimming stations), one Jumbo at creamery and one Alpha De Laval at each skimming station.

The Babcock test is almost universally adopted as a basis for payment for milk.

LENGTH OF SEASON AND SUNDAY WORK.

As already stated, almost all of the creameries in the coast regions run continuously throughout the year. A few stop during January and February. As for Sunday labor, there is some variation in practice, though the rule in the larger establishments is to operate on Sundays just the same as on other days. At San Bernardino only separation is done. This gives the patrons the skim milk for feeding and saves the housewives the care of the milk at home. In some other establishments no extra cleaning is done on Sunday, which somewhat shortens the day for the workmen.

MILK VALUES IN DIFFERENT MONTHS.

The returns made to patrons for milk, and the months during which high and low values rule, can best be shown by reference to reports received from widely distant parts of the State:

The San Bernardino Creamery Association reports returns per 100 pounds of milk during 1895, as follows: January, \$1.10; February, \$1.05; March, 90 cents; April, 75 cents; May, 70 cents; June, 65 cents; July, 80 cents; August, 90 cents; September, \$1; October, \$1; November, \$1; December, \$1.05.

W. W. Cocke, proprietor of the Star Cheese Factory, Downey, Los Angeles County, paid for milk, on a basis of 4 per cent butter fat, as follows: January, \$1.15; February, \$1.15; March, 74 cents; April, 74 cents; May, 78 cents; June, 87 cents; July, 87 cents; August, 95 cents; September, \$1; October, \$1.02; November, \$1.10; December, \$1.15.

P. A. Raab, proprietor of Bolsa Creamery, Orange County, reports payments per 100 pounds of milk as follows: January, \$1.10; February, 90 cents; March, 65 cents; April, 50 cents; May, 57 cents; June, 65 cents; July, 80 cents; August, 89 cents; September and October, not running; November, \$1.10; December, \$1.20.

The following are returns in cents per pound of butter fat for three creameries in Humboldt County in 1895:

1895.	Diamond Springs.	Excelsior.	Riverside.	1895.	Diamond Springs.	Excelsior.	Riverside.
January	22	.....	.....	July	14½	15	15
February	17	.....	.....	August	23½	21½	23
March	14	13	14	September	20½	19½	21
April	12	12	12	October	23½	23½	23½
May	11½	11	11	November	31	31	31
June	14	13½	13	December	26½	25	26½

Grizzly Bluffs Creamery, Humboldt County, reports the average value of butter fat for the year 1895 at 18.69 cents per pound. At the Star Creamery in Sacramento County, which is in the alfalfa pasturage region, the total milk received during the year 1895 was 2,684,240 pounds, which yielded butter at the average rate of 4.34 pounds to the 100 pounds of milk, and returned to patrons a net amount of

\$17,084.97, or $63\frac{2}{3}$ cents per 100 pounds of milk. The average price of butter was $18\frac{2}{3}$ cents per pound, the average freight and commissions a little less than 1 cent per pound, and the factory charge 4 cents per pound. This creamery had the advantage of a local market in the State capital, which is adjacent to the establishment.

PROPORTION OF CREAMERY PATRONS.

The creameries have usually succeeded in securing the patronage of nearly all the dairy farmers except in localities where the large-holding dairy system has brought creamery outfits into individual establishments, as already considered. An instance of this is in the Bodega district of Sonoma County, where but one-third of the dairymen patronize the creamery. In contrast to this state of affairs, in the leading valleys of Humboldt County more than nine-tenths of the dairymen carry milk to these establishments, while in the county as a whole more than one-half take this course.

DISTANCE OF MILK CARRIAGE.

The distance covered in carrying milk from the farm to the creamery is reported from Knights Landing, in Yolo County, where the distance is placed at 10 miles. As it is a region of riverside farms, it is contemplated to convey milk by a small steamer on the Sacramento River even from greater distances. The longest distances reported by inland creameries are 8 miles in Siskiyou County, 7 miles in San Luis Obispo and Mendocino counties, and 6 miles in Tulare and San Bernardino counties. Usually the longest hauls reported are 5 miles and the average from $1\frac{1}{2}$ to $2\frac{1}{2}$ miles.

FARM DAIRIES IN CALIFORNIA.

The farm dairy, as it is understood at the East, is very rare in California. What has been said of the beginnings of dairy work in this State shows that it did not spring from the farm house. Except at a few points in the early mining regions, where families drove their cows across the plains to the great dairy ranches on the coast, the dairy was man's work from milking to manufacturing. In early times in California women were too rare and precious to send into cow corrals or churn sheds. Profits were large enough to allow the dairy owner to hire all the men he needed, even at the high wages then current, and, besides, petticoats were things of which the cows of that day were in terror. As man was leader, the enterprise had to be large—for the Californian of that day had a horror of pothering with anything small—and rather than be in bondage to the family cow he would buy his butter and go without milk. While this condition has always prevailed in this State, and while on many ranches there were scores of horses and not a single cow, there has always been some farm-house dairying,

and with the increase of thrifty farmers milk and butter for family use are now generally provided, except in settlements of small fruit farmers whose land and time are too valuable for dairy production.

Of the methods prevailing in the California style of private dairies before the introduction of centrifugal separators it is not necessary to speak at length, because they are quickly passing away. The small pan setting of milk was universal until the introduction of hand separators, because the absence of ice and cool water, except in the mountains, made all deep-setting contrivances impracticable. Various designs for cooling by evaporating water from sacking or other fibrous material surrounding the milk receptacles were proposed, but never widely used, except in keeping cream taken from shallow pans to await churning. Dairy rooms with walls of porous terra-cotta plates, through which water might ooze from an outside source and evaporate from the inner surface, have been projected, but never existed except on the original drawings. Tight double-walled and double-roofed milk houses, closed during the day and opened at night, when the air is always relatively cool in California, are the sum of the cooling arrangements employed except in some of the more generously equipped concerns where small freezing-machine outfits have been introduced.

The frequency of churning in these private dairies depends upon the size of the herd. As someone of alleged skill is employed as butter maker, it is aimed to have milk enough to churn every day; but in the smaller concerns churning is done at different intervals, even once in four days, which is the longest time mentioned by any of our correspondents. In the dry air of California milk keeps in good condition, even though no low temperature can be secured. Dairy butter is almost entirely put into rolls and sold at once. If packed either by the producer or by the city receiver in a time of surplus receipts, the rolls are put down in casks in their original form, packing the rolls as closely as possible without spoiling their shape, and filling the cask with brine. This is known locally as "pickled roll," and it is usually sold, just as it comes from the brine, several months afterwards, though sometimes a sort of renovating process is practiced by freshening and wrapping the rolls in new cloth, but this revived "fresh roll" seldom deceives anybody. More recently the use of cold storage in San Francisco has reduced the amount of pickling. The ruling amount of salt used in California butter, both creamery and dairy, is 1 pound of salt to 20 pounds of butter, although individual makers report 1 pound to 16. There is a little difference in the amount used in summer and winter, say at the rate of one-eighth of an ounce to the pound more in summer than in winter.

The creamery and farm-dairy butters are sold in the same markets, and the product by the modern method has quite an appreciable advantage in price. This is proving a potent factor in the transformation and reequipping of ranch dairies, as well as inducing the establishment of cooperative creameries.

THE CALIFORNIA BUTTER ROLL.

The almost universal form given to the California butter product, both from creameries and private dairies, is the 2-pound "roll" or "square." The first is a cylinder, the second a parallelopipedon. The original form was the cylinder bearing the imprint of the maker on the upper end, and these were originally of 2 pounds weight and were packed in flat boxes with hinged covers, holding 60 rolls. The depth of the box is a little more than the height of the roll, a cloth being placed over the ends of the rolls when the box is closed. Each roll is wrapped in muslin or butter parchment paper. As purchasers bought the butter at so much a roll, there crept into the trade very early a practice of slightly reducing the weight of the roll, so that the retailer who bought the butter by the weight of the box would have more rolls to sell by the roll. The first retailer who conceived this bright idea was thus enabled to undersell his competitors on the price per roll, and the reduction of the weight was at first so slight as not to attract attention. But the departure from full weight set a vicious example, which was soon followed and exceeded until the "2-pound" roll weighed only $1\frac{3}{4}$ pounds. Retailers would not buy full-weight rolls because they could not meet the ruling prices for a roll, and the producers were obliged to reduce the contents of their butter molds or lose in the price they could get per pound. This little matter of the size of a roll has been a constant subject of discussion for the last twenty years. Finally, in 1893, the State legislature passed a law entitled an act to prevent the sale of short-weight rolls of butter: "Any person or persons, firm or corporation, who offers for sale roll butter not of full weight to each roll, shall be guilty of a misdemeanor." But the act does not define a legal roll. No effort has been made to enforce this law, but there has been a growing sentiment in favor of full-weight rolls. The California Dairy Association has resolved in favor of them, and many creameries resolutely make them, but it is probable that it will be some time before the "short roll" will wholly pass from view.

Since the introduction of creamery practice some butter has been marketed in tubs, but probably not more than one-tenth of the creamery product takes that form.

CALIFORNIA FORMS OF CHEESE.

The local form of cheese which was early adopted in California because of its portability and ease of cutting was what is known as a "flat." The flat has about the same diameter and half the height of the ordinary Eastern factory size, and weighs from 25 to 30 pounds. It had originally the local peculiarity of having the color in the bandage instead of in the cheese—a white cheese in an orange-red bandage. This style still prevails, but "Young America" and Eastern factory styles are now followed to some extent, and the use of color in the curd instead of in the covering is now the rule even when the old form is followed. There has been some disposition to introduce the Eastern

style of cheese box, but as the boxing has to be brought in the shook from the East, the use has been limited. Almost all the common forms of cheese originally come to the market "naked" or in packages of three cheeses in a burlap grain sack, and they are delivered by the receivers to the jobbers' or retailers' wagons in San Francisco without covering. When shipped to distant consuming points, two or three cheeses are cased in a square box made so as to fit closely and the cost of casing charged up to the cheese producer. This burden he has always protested against, especially as the charge for casing has been thought to yield the commission man something more than the service actually cost him. More recently a well-made box or case has come into use. It carries several flat cheeses and is returned to the factory by transportation companies without charge when empty.

Almost all the cheese made in California (except that made occasionally in creameries during low butter prices) is the product of proprietary concerns, and probably nine-tenths of it is from milk produced by cows owned or leased by the maker. The product is therefore almost wholly farm or ranch cheese, but the reader will understand that many of these farms produce as much milk as is received by the smaller Eastern "factories" and manufacture it in as enlightened a manner. Farm dairy cheese, as the term is used in the East, is hardly known in California. In country stores, however, there are always adequate supplies of California dairy or factory cheese, and it is retailed at all prices from 9 to 20 cents per pound, according to quality or distance from producing points. The average price for California cheese at retail is $12\frac{1}{2}$ cents per pound.

Of the cheese branch of California dairying it may be said that it has never been developed as the natural adaptations of the State suggest. The prejudice for Eastern cheese, which has already been mentioned, is a serious obstacle and prevents the local producer from securing even the best of the local trade, which through limited population is necessarily small. There is at present no distant market which invites supply. The lack of inducement is perhaps to be cited as the reason why the local cheese interest has never developed commensurately with the butter interest. And yet California conditions favor the cheese maker in a notable degree. The dry air rules out that condition of "mugginess" which gives the Eastern factory man so much milk which calls for the use of high acid in the curd. The milk, in all save the hot interior at least, is clean and good. Some makers declare that in an experience of years they have never seen a "floating curd," and one maker reports from Humboldt County that it is the "easiest place to make cheese" he ever saw. This is common observation, and the fact that the sweet-curd process is widely employed is also very significant.

DAIRY MARKETS OF CALIFORNIA.

San Francisco, with thrice the population and more than thrice the local and distributing trade of any other California city, has always

been naturally the great dairy market of the State. There is in fact only one other city which approaches even to one-third of the dimensions of San Francisco; that is Los Angeles, and she has only recently arrived at this estate. The growth of Los Angeles, and southern California generally, has, however, recently created a diversion of a part of the dairy trade southward, for the consumption of dairy goods in southern California is still considerably greater than the increased local production. Speaking generally, the surplus dairy production of the northern two-thirds of California goes to San Francisco and of the southern one-third to Los Angeles. Along the borders of this division shipments go either way, as the demand seems to warrant; but aside from this general movement, San Francisco reships large quantities to southern California, and sometimes the product of Nevada creameries goes direct to Los Angeles as a better market than San Francisco.

The receipts of butter and cheese in San Francisco during the year 1895, as compiled by the Journal of Commerce, were as follows:

Butter:	Pounds.
California manufacture	13, 796, 000
Oregon	413, 000
Eastern	184, 500
Total.....	14, 393, 500
Cheese:	
California manufacture.....	4, 624, 500
Oregon	132, 400
Eastern	1, 738, 270
Total.....	6, 495, 170

The extension of the creamery interest in California has taken from San Francisco somewhat of its importance as a distributing market to the towns of the State, because creamery managers have developed direct trade with jobbers and retailers in the smaller towns as far as possible. Formerly there were large supplies sent from San Francisco to Portland and the Puget Sound cities. Recently the dairy development of Oregon and Washington, and the enterprise of the creamery interests of the region northwest of Chicago to ship their surplus westward by the Northern Pacific, have very much reduced California's sales in the northern regions of our coast. These regions are, in fact, so well fitted for dairy production that they will probably soon have a considerable surplus, for which they must seek distant markets.

San Francisco enjoys the distinction of being the third port of the United States in the export of dairy produce, New York and Boston alone exporting larger amounts; but this distinction is secured upon a very small volume of trade. The total valuation of the butter and cheese exports from San Francisco in 1894 was \$118,530, and in 1895, \$99,075. Of these amounts nearly one-half went to British Columbia, and for this trade in the future California must contend with the development of local production in the Dominion and compete with the

coming surplus in the nearer States of Oregon and Washington, already alluded to. The other half of San Francisco's exports of dairy goods is distributed all over the countries bordering on the Pacific, including the Hawaiian Islands, the Asiatic countries, the islands of Oceanica, Mexico, and Central America—a magnificent geographical area, but one in which dairy demand is confined almost entirely to the small colonies of Europeans located at points of commercial importance. Californians have indulged in some speculations as to the possibility of developing dairy trade in these densely populated parts of the world, especially in Japan, and the same intention has been disclosed by the shippers of creamery products from the region northwest of Chicago, but there is much doubt whether these Asiatic people will change from their long established food supplies much faster than they will learn to produce for themselves. Shipments of dairy cattle have been frequently made from California to Japan during the last ten years, and their acquisition of dairy arts may be expected.

EASTWARD SHIPMENT OF CALIFORNIA BUTTER.

Some moderately encouraging results have been attained in shipping fresh California butter to the regions east of the Rocky Mountains during the closed season of Eastern dairies, but the growth of winter dairying at the East, the improvements in cold storage, and the improvement of Eastern winter-made butter by the use of succulent silage in connection with the old style of wintering on dry feed, coupled with the vast superiority of the keeping quality of creamery butter over the old firkin product, tends to reduce the field which California fresh winter butter might have enjoyed if the Eastern product had not thus improved. Still it is hoped that by developing the creamery system here, and thus rendering available large uniform lots of butter for Eastern shipments before the Eastern grass butter comes forward, California may find some outlet eastward at favoring times of the year for an amount at least equal to the shipments from the East to California during the months when our output is small. Either this must come or some very notable increase of local population, by the development of mining interests which are now very promising or by other local industrial advancement, is necessary, before any great increase of the present dairy production of California will be warranted. In fact, in the upper San Joaquin Valley, with no large towns and a long haul by rail through a hot valley to reach either San Francisco or Los Angeles, two cheese factories did not open in 1896 because of oversupply in local markets. But while this is the case, there is still a steady consumption of Eastern and foreign cheese in preference to California cheese. For the last five years this supply has averaged about 1,750,000 pounds annually, and this continues, although California producers have made some effort to give their product the form and character of the popular Eastern and European cheeses. There is a prejudice among certain classes of

consumers for "imported" goods which handicaps local producers in their efforts to produce similar articles. This is in part inexplicable, and in part due to the inheritance of a bad name from our earlier years of careless dairying.

DAIRY ORGANIZATION AND PROTECTION.

The first State Association of California Dairymen was organized in 1876. It was modeled after the leading associations east of the Rocky Mountains. Several interesting conventions were held in San Francisco, but the dairy public did not manifest the interest which was expected and the effort was abandoned. In 1882 the industry was menaced by a proposition to establish an oleomargarine concern in San Francisco, and this provocation rallied the legitimate producers in a large convention held in December of that year. A draft of an enactment against imitation dairy goods was agreed upon and it was passed by the California legislature in the winter of 1883. It was a good law, but it offered no reward for information and the dairymen relaxed their cooperative efforts as soon as the law was safely inscribed upon the statute book. There was then no machinery to promote prosecution, and the only effect of the law was to prevent local investment in oleomargarine enterprises. Year after year, however, imitation products were brought in from the East and freely sold in defiance of the law without prosecution. Just as soon as prices showed a tendency to advance with the lessened dairy production of the autumn, great quantities of the spurious goods were shipped overland to California, to the great distress of producers of the pure article. The passage of the United States law led to delay in the hope that it would check the evil. At last, in 1893, it was evident to dairymen that they must do something more effective than they had yet accomplished in their own behalf, and a new association, called the California Dairy Association, was organized in the fall of that year, which has constantly increased in membership and has full promise of permanence. It held excellent conventions in San Francisco in 1894 and 1895, and during the present year has held monthly meetings at different dairy centers in addition to its annual convention. But the chief achievement of the association, supported by the dairy interest at large, was done at the session of the California legislature of 1895 in the enactment of a new dairy protective law and the creation of a State dairy commission to enforce its provisions. The law providing for these two results was approved March 9, 1895, and is condensed as follows:

The coloring of oleomargarine or other imitation product in imitation of butter or cheese made from unadulterated milk is absolutely prohibited. And the possession of, sale of, or offering to a patron for consumption, such imitation product when colored to imitate the genuine, is a misdemeanor.

The use of the words "butterine," "dairy," "creamery," or of dairy symbols in connection with the sale or advertisement of the imitation product is absolutely prohibited.

In the handling of the imitation product, the manufacturers, shippers, carriers, wholesalers and retailers, peddlers, bakers, hotel, restaurant, and boarding-house

keepers must comply with certain regulations as to the labeling of the packages, the specification by printed statement of the contents and the proper notification of the purchaser, consumer, or patron.

Other provisions of the law invalidate a contract made in violation of the act, prohibit the use of imitation products in charitable institutions; make the effacement of labels and marks a misdemeanor; provide what is evidence of intention to violate the act; authorize the State Dairy Bureau to make use of the search warrant; require the district attorney to prosecute and the informer to receive half of the fines; and establish a State Dairy Bureau for the period of two years and with a fund of \$12,000 for the enforcement of the act. Violation of any of the provisions of the act is a misdemeanor, and a first offense is punishable by a fine of not less than \$50 nor more than \$150 or by imprisonment for not more than thirty days; and subsequent offenses are punishable by a fine of not less than \$150 nor more than \$300 or by imprisonment for from thirty days to six months, or by both.

In compliance with the terms of this law, Messrs. L. Tomasini, Thomas Flint, sr., and George W. Burbank were appointed to constitute the State Dairy Bureau, which began on May 1, 1895, a vigorous prosecution of the law. This action resulted in the abandonment of a projected local manufactory of oleomargarine, and vigilance on the part of the bureau has reduced the trade in imitation products made elsewhere to a very small aggregate. This result, coupled with the low price of butter, has practically freed California, for the time being, at least, from competition with imitation products which had been for years very grievous. The secretary and executive officer of the bureau is William Vanderbilt, and the offices are at 113 Davis street, San Francisco.

In addition to the foregoing official organization for dairy promotion and protection, are the following voluntary associations for the purposes specified:

CALIFORNIA DAIRY ASSOCIATION.—Incorporated September 2, 1893, for educational and legislative objects. Directors: Joseph Mailliard, president, San Geronimo; A. P. Martin, first vice-president, Petaluma; William N. Russ, second vice-president, Eureka; John A. Cole, third vice-president, San Bernardino; F. H. Green, treasurer, San Francisco; Samuel E. Watson, secretary, San Francisco; W. W. Wynn, Livermore; William Niles, Los Angeles; R. H. Brown, Pescadero; H. M. Le Baron, Valley Ford; P. Tognazzini, Cayucos. Meets monthly at different points and holds annual convention. Reports sent on application to secretary, 113 Davis street, San Francisco.

DAIRYMEN'S UNION OF CALIFORNIA.—Incorporated August 17, 1891, with capital stock of \$250,000, subscribed by dairymen, to carry on a general commission and produce business. Directors: Warren Dutton, president; G. W. Burbank, vice-president; E. W. Steele, treasurer; J. R. Denman, secretary; L. Tomasini, manager; Samuel Donati, F. Madonna, P. Tognazzini, A. Tognazzini, M. Righetti, S. Cheda. Location of business, 113-119 Davis street, San Francisco.

DAIRYMEN'S ASSOCIATION OF SOUTHERN CALIFORNIA.—Organized in July, 1894, for educational and legislative purposes. Directors: D. Durkee, Rincon; C. E. Mitchell, Clearwater; W. H. Smith, Norwalk; P. F. Cogswell, El Monte, and G. E. Platt, Los Angeles. Officers: C. H. Sessions, president, Los Angeles; George H. Peck, vice-president, El Monte; R. R. Risdon, secretary, Los Angeles. Meets quarterly, on the second Saturday of January, April, July, and October.



BULLETIN No. 15.

(Dairy No. 6.)

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

THE CHEESE INDUSTRY

OF

THE STATE OF NEW YORK.

BY

B. D. GILBERT,

Special Expert Agent, Dairy Division.

Under the direction of

Dr. D. E. SALMON,

Chief of the Bureau of Animal Industry.



WASHINGTON:

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1896.



LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., October 17, 1896.

SIR: I have the honor to transmit herewith a report upon the Cheese Industry of the State of New York, prepared under the supervision of Henry E. Alvord, chief of the Dairy Division, by Benjamin D. Gilbert, special expert agent of that division. Mr. Gilbert is secretary of the New York State Dairymen's Association, and has been for years secretary of the Utica Board of Trade and dairy editor of the Utica Herald. The report includes a chapter describing in detail the most approved method of making full-cream factory cheese, by G. Merry, also special agent of the Dairy Division.

It is respectfully recommended that the two reports be combined and published as a bulletin of this Bureau.

Very respectfully,

D. E. SALMON,
Chief Bureau of Animal Industry.

Hon. J. STERLING MORTON,
Secretary.



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THE CHEESE INDUSTRY OF THE STATE OF NEW YORK.

By B. D. GILBERT,
Secretary New York State Dairymen's Association.

HISTORY OF CHEESE MAKING IN NEW YORK STATE.

LOCALITIES WHERE FIRST UNDERTAKEN.

The art of cheese making in this country dates back a hundred years or more from the present time, but the science of cheese making, or its manufacture on scientific principles, is not 50 years old, and is far from being fully understood in this year of grace 1896. Thirty years ago Mr. X. A. Willard, who was then the chief expositor of our cheese industry in the public journals and pamphlet literature of the day, stated in an address before the American Dairymen's Association that he remembered to have seen the persons who first began cheese dairying in Herkimer County, N. Y., and to have eaten of the product of their manufacture. This would carry cheese making in Herkimer County back to the early part of this century; but the following statement indicates that this art was practiced at an earlier date in a county farther south. In a volume entitled *Memoirs of the Board of Agriculture of the State of New York for the year 1826*, there is a paper on "The manufacture of butter and cheese," by S. DeWitt, of Albany. In it he says:

When I first came to Albany more than thirty years ago, I found a Mr. Hudson, an Englishman, settled as a farmer near Cherry Valley, celebrated for his excellent cheese; afterwards a Mr. Tunnicliff, also an Englishman, on the Susquehannah, equally celebrated in the same way. I have had cheese from both which would not suffer in comparison with the best from England of the same age.

This takes us back to 1795 or 1796, and locates cheese making at that time in what is now Otsego County. It gives the honor of beginning the art in the State of New York to native-born Englishmen, and shifts the scene from Herkimer County to Otsego County.

But while it is probably true that Herkimer was not the pioneer county in making cheese in this State, it is certainly true that she soon forged ahead of all other districts, and maintained her lead with great preeminence down to the introduction of the factory system in 1851. That cheese was made there early in this century is attested by a

Mr. Osborn, who spoke at a meeting of the State Agricultural Society in 1854. He related how Daniel Day came from Uxbridge, Mass., about the year 1808, and settled in the town of Newport, "a wild, woody region, and a hard country for new settlers." Here he purchased 200 acres of land and stocked it with ten or twelve cows and some sheep. The old man had formerly been connected with a manufacturing establishment "down East," and twice a year he would take off a load of wool, butter, and cheese and bring back a load of factory goods in exchange. In 1813 Mr. Osborn's father purchased the Day farm, and continued to carry on the same business. His description shows how crude were the methods in vogue:

There was the cheese press, a simple bench 8 or 10 feet in length, with a frame at one end for the lever, and guides for this lever at the other end, and then another lever over these guides the other way to raise the weight on the end of the pry. The cost of this press was about \$1. All the other utensils of the dairy were about after the same order. There was a constant strife between the cheese hoop and the churn as to which should have the lion's share of the cream. During the summer season when there was some risk in making butter, much of the cream went into the cheese, and as cold weather approached it was pretty evenly divided; but late in the fall cheese was sometimes made of the pure sky blue, the classical name of which was "white oak." Whether it acquired this name from the resemblance of its color to the wood or from its toughness is uncertain.

So it seems that the same tactics were practiced eighty years ago, in the infancy of the business, as are current now, and probably will be as long as cheese shall be made.

It is a curious fact that some of the earliest things published in this country on the subject of cheese making were descriptions of several varieties of cheese made on the Continent of Europe which have never yet been produced here with success. In the same memoirs of the State board of agriculture quoted above, but in the volume for 1823, there is a description of a Parmesan cheese dairy, together with directions for making Edam, Swiss, and Brie cheese, thus representing the make of four different countries on the Continent. By that time there must have been a considerable amount of cheese made after the English style in the interior of the State, for Mr. De Witt asked in 1826, "Why is it that while tons of this article (cheese) are brought to our market (Albany) it is so extremely difficult to find any which a man of taste would tolerate on his table?" The fact is that the Dutch of the Mohawk Valley, whose ancestors might have brought over some knowledge of making the kinds of cheese known in Holland, seem to have entirely lost the art. Mr. Aaron Petrie, of Little Falls, stated in a letter to the State Agricultural Society, in 1841, that "about 1820 the dairy business began to attract attention in the northern part of Herkimer County, particularly cheese making. All who adopted it flourished at once, and it is another instance of the difference of policy pursued by the descendants and settlers of New England and their Mohawk neighbors that the benefits of dairying were confined to the former for at

least ten years, and indeed until the sterility of the once fertile land of the Mohawk compelled the latter to adopt it."

METHODS PRACTICED IN EARLY TIMES.

In those early days cheese was made in a more or less haphazard fashion and on a comparatively moderate scale, since it was all made in private dairies and principally by the women of the household. The amount of milk was necessarily limited, the dairies ranging from 10 or 12 to 35 or 40 cows, so that there was no difficulty in working it in large tubs.

Heating the milk.—There was difficulty, however, in applying heat, and this was one of the causes which rendered the product uneven in quality, although made by the most practiced hand. Various methods were used for this purpose. One writer gives the following description:

Milk is put into a brass pan and made scalding hot by placing the pan on a furnace or in a vessel of hot water; then one-half of it is poured into the cheese tub among the cold milk and the rest into a pan in which the cream had been put. The cream and the hot milk being intimately incorporated, the whole is poured into the cheese tub, which by this time has received great addition, if not the whole of the morning's milk warm from the cows.

Another method is described as follows:

A brass kettle nearly filled with water is then suspended in the vat, reaching within 4 inches of the bottom, into which is inserted a lead pipe attached to a patent steamer; the mass is then warmed to 85°, being stirred gently with the hand during the time of warming. The heat is then increased fast enough to bring the whole mass up to 100° F. in forty minutes.

The degree of heat was in many cases simply guessed at from contact of the hand with the milk. As late as 1842 a maker who took a prize at the State fair with his cheese, in describing his method of manufacture, said:

The milk when ready for the rennet should be some degrees less than milk warm (*as I never have used a thermometer I can not say how many*).

The same man says that his cheese are pressed "by means of a weight on one end of a lever resting on the cheese follower as a fulcrum near the other end." This was the single-lever press. The double lever has already been described.

Rennets.—Another cause of poor cheese was the slovenly and inadequate preparation of the rennets. There is more literature on this subject in the publications of that period than on any other topic of the dairy. What kind of rennets to use, how to feed and when to slaughter the calf, how to clean and dry the rennets, what color a good rennet should have, how to preserve and keep it for the proper length of time, are all subjects that are discussed elaborately. As late as 1866, Mr. Weeks, the secretary of the American Dairymen's Association, stated that "a substitute for rennet that shall be cleanly and of uniform strength is what we most need in cheese making."

Lack of apparatus.—In those days there was no patent apparatus to lessen the work of the cheese maker. Success or failure depended wholly on the judgment of the individual, and that was formed by a long period of apprenticeship and by the experience gained through years of hard and faithful work. Women as a rule made the cheese; they did even more than that, they helped milk the cows in the open air, often out in the rain or snow, and they also took care of the milk. The fact that American cheese not only met with a large sale at home, but by the year 1847 was exported to the amount of 15,637,600 pounds, speaks well for the skill of our foremothers in manufacturing this product of the dairy.

Measuring the milk.—As late as 1842 the amount of milk used in cheese making was measured by gallons instead of pounds. For instance, one writer produces the statistics of his dairy, which show that in September 674 gallons of milk made 733 pounds of cheese. From October 1 to October 9, inclusive, 523 gallons made 643 pounds, while from October 10 to October 19, inclusive, 574 gallons made 683 pounds. This showed that it took less milk to make a pound of cheese as the season progressed, but it was impossible to establish a ratio. When the manufacture of cheese assumed larger proportions, especially after the introduction of the factory system, it was found very inconvenient to have one standard for measuring milk and another for measuring its product. Evidently the cheese and butter could not be measured by quarts and gallons, so in order to unify the standards it was determined to measure the milk by pounds. This was rendered absolutely necessary by the requirements for handling milk at the factories. If measured by the quart or gallon it would take the whole day to credit the different patrons with the amount of milk delivered by each. But the moment that milk began to be measured in pounds, the whole matter was simplified, and the ratio between milk and its products, butter and cheese, could be established without difficulty.

Marketing.—The manner in which cheese was put up for transportation should also be noticed. Originally the cheese had no protection or covering; they were laid carefully in the bottom of a wagon covered with straw, in order to carry them to market or to peddle them around the country. At this time, it should be noted, not even a bandage was put around the cheese. In the next improvement long, rough casks were made, in which from four to six cheeses were placed, one on top of the other, so that a number could be handled at a time without much injury to the cheese. In this shape cheese was sent to the New York market for many years, and it is still the manner in which Swiss cheese is shipped, both in this country and abroad. Finally, the plan of boxing each cheese separately was adopted, and about the same time our makers began to use bandages around the cheese. The first evidence of this which appears in the market reports is found in December, 1841. Previous to that time, the stock had been quoted as "Cheese Am."

(American). But that winter a new quotation appeared. Cheese "in bxs." was quoted at 7 @ 8c., while cheese "in casks" brought only 6 @ 7c. The modern idea that neatness in putting up any article of food is an element in the successful sale of that article found an immediate practical illustration in the sale of cheese. Probably the cheese put up in boxes was no better in quality than the cheese that was shipped in casks; but the more tidy appearance of the goods that were boxed, and the protection afforded by the boxes, caused them to sell for a cent a pound more than the old style as soon as they appeared in market.

About the year 1830 the production of cheese had become sufficiently large to engage the attention of special buyers. The product was not then sold as it is now, at twenty to forty days from the hoop. The whole season's production was kept until fall and then marketed in the bulk, just as butter used to be and still is, in some of the remoter districts. From 1810 to 1830, which was the introductory period of manufacture, the product was peddled around the country by the farmers themselves. One might imagine that cheese made and sold under these circumstances would not only not meet the requirements of our modern tastes, but would hardly be a palatable article of food for less critical and more uncultivated tastes. But it is a fact that the cheese makers of that early day threw remarkably well, so much so that their numbers increased rapidly; and this furnishes good evidence that their product was liked and appreciated by the public of that day, however much it might be criticised by a consumer of the present time.

As soon as the idea gained a foothold in the minds of traders that there was money to be made in handling this product of the dairy, they began to make a regular business of buying cheese. Starting out early in the fall, they carefully canvassed the entire region where this industry was carried on, contracting for the whole season's make of as many dairies as they could buy at figures which promised them a profit. Whatever stock was sent to tide water went by canal, and a moderate proportion of the cheese contracted for by buyers during the twenty years between 1820 and 1840 was sold to exporters.

EARLY CHEESE MAKING IN NEW ENGLAND.

How long ago cheese was made in New England it is not easy to discover. We know that in 1802, soon after the inauguration of Thomas Jefferson, a delegation went from the town of Cheshire, Mass., to Washington, D. C., taking with them, on a wagon drawn by six horses, a mammoth cheese for presentation to the President.¹ The committee also carried with them an address from the inhabitants of the town with the

¹ It is a curious fact, in line with President Jefferson's big cheese, that in the early days of the factory system Mr. Willard spoke of large cheeses weighing 700 to 1,000 pounds as being frequently made, and as bringing 17 cents per pound when cheese of the ordinary size would sell for only 10 to 12 cents.

inscription, "The greatest cheese in America for the greatest man in America." As early as 1819, at the first exhibition of the Worcester, Mass., society, there was one premium given on cheese and it was awarded to Messrs. John and David Hunter, of North Braintree. This was the banner town in cheese making for many years afterwards. In the report of the society for 1852 it was stated that at all the exhibitions held there for thirty-three years a majority of the premiums on cheese had been bestowed on citizens of North Braintree. It was also stated that "our farmers had an opportunity of examining specimens of cheese from New York, and we may hope for similar favors from other States." In 1851 the report of the Hampshire society contained a flattering statement concerning New York dairymen. It said:

May the day soon arrive when our dairies shall become to old Massachusetts all that the dairies of New York are to the Empire State. The average annual product in 1846 of the dairies of Herkimer County ranged from 500 to 650 pounds of cheese per cow. A Mr. Rottier, of Jefferson County, in 1849, produced from 26 cows an average of from 125 to 150 pounds of butter and from 300 to 400 pounds of cheese per cow. When the farmers of the Connecticut Valley *will* to have such products, with the blessing of God they will come.¹

This shows that, as far back as the forties, New York State was leading the rest of the country in cheese making.

EARLY CHEESE MAKING IN PENNSYLVANIA.

In Pennsylvania also there was cheese made for family use at an early date. MacMaster, the historian of the people of the United States, informs us that in Lancaster and other towns in the neighborhood of Philadelphia many of the settlers were Germans who possessed great thrift and industry.

With the exception of fresh meat, everything the German ate grew upon his own land. His food was chiefly pork and rye, onions and sauerkraut, milk and cheese, and turnips and Indian corn. The good wife and her daughters worked the loom, made the cheese and butter, and when the harvest came toiled with the sickle in the field.

This was in the year 1800.

¹The figures, however, are exaggerated and misleading, as may be seen by analyzing them. For example, 150 pounds of butter in those days would require 3,750 pounds of milk, and 300 pounds of cheese would take 3,000 pounds of milk, making a total yield of 6,750 pounds of milk from each animal in a dairy of 26 cows. There are comparatively few dairies even now that will give such an average yield as that. As for the "annual average product" of Herkimer County dairies ranging from 500 to 650 pounds of cheese in 1850, such a statement is hardly to be credited. In the report of the New York State Agricultural Society for 1844, Mr. Alonzo L. Fish published an account of the management of his dairy farm in Herkimer County. He stated that in 1842 the average product of cheese from his dairy of 25 cows was 714 pounds, while in 1843 the average was 650 pounds, one-quarter of the animals being heifers. Possibly this was in the mind of the writer who gave the above-quoted estimate for Herkimer County.

STATISTICS OF CHEESE PRODUCTION.

The statistics of any business form the touchstone by which to judge of its prosperity or the reverse. There are no statistics of the cheese business in this country which can be relied upon previous to the United States census of 1840. It is stated in Transactions of New York State Agricultural Society for 1851 that "the first exports (of cheese) were in 1789, but they were very inconsiderable and were not of an extent to command even the attention of Congress till 1820." Prior to the last-named date the statistics of exports and imports were reported very imperfectly, while no attempt had been made to gather the statistics of production. By the act of Congress under which the census of 1820 was taken the name and nature of certain articles manufactured, their market value, and some other details were given; but cheese and butter were not included, and the figures were all so poorly collated and so unsatisfactory that in the census of 1830 no attempt was made to secure industrial statistics.

PRODUCTION OF NEW YORK STATE COMPARED WITH THAT OF THE WHOLE UNITED STATES.

In 1840 the value of dairy products of all kinds was taken together and without record of quantities; the value for the whole United States was \$33,787,008, New York State producing \$10,496,021 of this amount. When the State census was taken in 1845 it was estimated that one-third of the 999,400 cows employed in the dairy throughout the State were devoted to the manufacture of cheese, giving 36,744,976 pounds in all, or about 110 pounds per cow. This was probably not far from correct, although if there was an error it lay in the direction of under-estimating. We have the actual figures giving the tons of cheese moved on all the State canals in 1846 and 1847. In the first-named year 15,417 tons of New York State cheese were transported, besides 3,616 tons from other States and Canada. In 1847 the New York State cheese carried amounted to 15,983 tons, along with 4,056 tons from other States and Canada. If we turn the long tons of State cheese into pounds, we find that in 1846 there were 34,534,080 pounds, and in 1847 there were 35,801,920 pounds, showing an increase of 1,267,840 pounds during the year. Undoubtedly there was a considerable amount of cheese sold at markets where it could be delivered by team, and this, added to the quantity transported by canal, would indicate that the census estimate for 1845 was pretty nearly correct, although probably somewhat smaller than the facts would warrant.

The national census of 1850 credited New York State with producing 49,741,413 pounds of cheese, but the State census of 1855 gave only 38,944,240 pounds, a decrease of 10,797,173 pounds. This would be difficult to explain if it stood alone, especially as the number of milch cows in 1850 was only 931,324, while in 1855 the number of cows had risen to 1,123,634, a difference of 192,310 in favor of the latter

year. A partial explanation seems to be that there was a heavy increase in the production of butter, the price rendering it more profitable to convert the milk into butter than into cheese. The production of butter in 1850 was 79,766,094 pounds, while in 1855 it had increased to 90,293,073 pounds, an improvement of about 12½ per cent. If we convert the butter product of 1850 and that of 1855 into their equivalents in cheese and add to each the cheese product of those two years separately, it will be found that the total for 1855 exceeds the total for 1850 by only 15,500,000 pounds. Divide this by the excess in number of cows in 1855 and it gives a product of only 80 pounds of cheese per cow, or just one-half the estimated production of cheese per cow in 1850. The probability is that there was some error in the State census of 1855, inasmuch as the census of 1860 showed a production of 48,548,288 pounds, or within 1,200,000 pounds of the product in 1850. Presumably the production of cheese during the decade that extended from 1845 to 1855 was fairly even and steady, while that of butter was considerably increased, along with the increase in the number of cows.

Down to this time the introduction of the factory system seems to have made no great difference in the quantity of cheese made either in New York or in the whole United States. There was comparatively little change either in the absolute or the relative amounts. The figures are as follows:

Year.	United States.	New York.
	<i>Pounds.</i>	<i>Pounds.</i>
1850.....	105,535,893	49,741,413
1860.....	103,663,927	48,548,289

A decrease of 1,871,966 pounds for the whole country is less than the decrease of 1,193,124 pounds for the State alone; but both amounts are small and not especially significant where such large totals are concerned. When we reach the State census of 1865 we find that a long stride forward has been taken. The figures for that year were 72,195,337 pounds, showing an increase in the State of 23,647,048 pounds, or 48½ per cent. This was the result of the wonderful extension of the factory system. During the period from 1851 to 1860 this system was in an experimental stage. Even in 1861 Mr. Willard spoke of the system as having been but lately introduced, and said:

A brief statement has been made as to this plan of cheese manufacture because it is comparatively new, and because it may possibly prove suggestive, not only to persons already engaged in dairying, but as offering a feasible plan for those unacquainted with the art in districts where it is proposed to introduce dairy farming.

And in 1871 Hiram Walker said:

It is but nine years since the first cheese factory was erected in Oswego County.

It evidently took about twelve or thirteen years for dairymen to make up their minds whether or not the factory system was advantageous and was going to prove a success.

The next five years showed an increase of 28,580,675 pounds, bringing the total up to 100,776,012 pounds, an improvement of very nearly 40 per cent. This was under the national census, and we are therefore able to compare the yield of this State with that of the United States. It will make the matter somewhat clearer to put the figures in tabular form.

Year.	United States.	New York.
	<i>Pounds.</i>	<i>Pounds.</i>
1870.....	162,927,382	100,776,012
1880.....	103,663,927	48,548,289
Excess of 1870.....	59,263,455	52,227,723

This is a most remarkable statement, inasmuch as it shows that while New York had increased her production more than 52,000,000 pounds, or considerably over 100 per cent, during this decade, all the rest of the United States had only increased by the comparatively small amount of 7,035,732 pounds. Probably it will be said that the civil war prevented the extension of cheese manufacture in other States, but it is not easy to discern why the war should have had more effect in other Northern States than it did in New York. The more probable explanation seems to be that New York, being the State in which the factory system originated, appreciated more readily the importance of the system and was quick to take advantage of the enormous prices paid for cheese during the years 1863 to 1870.

The State census of 1875, the last one taken, again showed a small decrease of 2,050,840 pounds. This is only 2 per cent of the product of 1870, while the increase in the production of butter amounted to 3 per cent, thus showing where and how the milk had been used. The national census of 1880, however, gave an increase of cheese made in this State amounting to 30,438,542 pounds, or a little less than 31 per cent, and bringing the total up to 129,163,714 pounds, the highest total production of cheese ever reached in the State according to a United States census. That year New York made 56½ per cent of all the cheese produced in the United States. The figures for 1890 were not so favorable, being only 124,086,524 pounds, a shrinkage of 5,077,190 pounds, or 4 per cent, while the production of the whole country was 13,604,033 pounds greater than in 1880. There seems to be no doubt that the manufacture of cheese was then really on the wane in this State and that it has continued to decrease since that time.

FARM DAIRY CHEESE.

In the case of cheese made on dairy farms this reduction is especially noticeable. The census figures show this very plainly, as follows:

Farm dairy cheese made in the State of New York in—

	<i>Pounds.</i>
1875.....	7,778,413
1880.....	8,362,590
1890.....	4,324,028

There was an increase in this class of goods between 1875 and 1880 of nearly 6 per cent, but in the decade between 1880 and 1890 the shrinkage was almost 50 per cent. This is easily accounted for by the fact that many factories which ordinarily made large sizes found it to their advantage to change their style in the fall and manufacture small sizes, such as are usually made in private dairies. As a rule dealers prefer to handle factory-made cheese, especially when produced in a well-known establishment, where the stock is likely to prove more uniform in its character. This and the growing distaste of the women of the farm to continue the hard labor involved in cheese making have vastly diminished the amount of farm dairy goods and bid fair to nearly eliminate them from the market.

PRODUCTION IN NEW YORK IN 1895.

Inasmuch as no State census of New York was taken in 1895, it is impossible to give absolute figures for the cheese production of that year. An attempt has been made, however, to get at these statistics as accurately as was feasible without resorting to actual census methods. The transactions of the different boards of trade in the State for the season of 1895 have been obtained, as well as the purchases of many individual buyers in other parts of the country. From a number of the large combinations in the western part of the State also the statistics of their manufacture have been received, and in addition to these an estimate on the unreported and unknown sales to home buyers and to dealers in those parts of the State which have no public market, has been made upon principles which will be explained hereafter. In making up this estimate one great fact had to be steadily borne in mind. The drought of the summer of 1895 was the longest and most severe of any that has occurred in this State in a quarter of a century, which means since boards of trade were established in the interior of the country. In the central and northern parts of the State the shrinkage in the output of cheese was fully 20 per cent; in the western part it ranged from 25 to 33 per cent. Early in June the poor condition of grass began to show itself, and it was attributed to a combination of causes. Prominent among these were the long drought of the previous season, which killed the roots of the grass and seriously thinned the meadows, and the heavy frosts which occurred both early and late in the spring of 1895, the latest occurring the morning of May 22. From the middle of June to the middle of July there was no rain and the hay crop was fully one-quarter short. There were occasional showers after that, but cows kept right on shrinking in their milk yield, which was no larger the 1st of August than it usually is on the 1st of October. In the western part of the State the drought was so severe that in some instances boughs of trees were lopped off that cattle might feed on the leaves. Some dairymen were even prosecuted at law because they actually starved their cattle. They had nothing on

the farm to feed to the cows, and could not or would not buy sufficient food to keep them from suffering.

In order to show upon what foundation the estimate of the production of 1895 is based, the figures obtained from different sources are here collated:

Boards and markets.	Number of boxes.
Utica Board of Trade	218,545
Little Falls Board of Trade	150,207
Watertown Board of Trade	98,845
St. Lawrence County Board of Trade	85,000
Fulton Board of Trade	49,656
Ogdensburg Board of Trade, about	32,000
Gouverneur Board of Trade	21,730
Marketed at Cuba, Allegany County	86,250
Marketed at Norwich, Chenango County	82,300
Marketed at Lowville, Lewis County, about	85,386
Seven combinations in Cattaraugus County	80,081
Total	990,000

These figures are as nearly correct as it is practicable to present. They represent approximately the production of the counties of Oneida, Herkimer, Chenango, parts of Madison and Otsego, Montgomery, Jefferson, St. Lawrence, Lewis, Oswego, part of Onondaga, Allegany, and parts of Cattaraugus and Chautauqua.

For the benefit of those who are not familiar with the cheese trade it may be well to state that "boxes" of cheese vary in size and weight, ranging from 34 pounds for a small sized home-trade cheese up to 75 pounds for large-sized export cheese. It has always been the custom at the Utica Board of Trade to estimate the average weight of boxes throughout a season at 60 pounds, and the same estimate was adopted by Hon. B. F. Van Valkenburgh, assistant dairy commissioner of this State, in making out his reports for publication. A similar result was arrived at by the secretary of the Watertown board, who wrote to a number of dealers and organizations for their views and published the answers. A large majority agreed that 60 pounds was a fair average weight for the cheese produced in New York. In the ordinary method of reporting the markets the number of boxes is given, and not the number of pounds. There is so much difference in the weights of the separate cheese that it would be wholly impracticable to figure out the exact amount in pounds. Therefore, in writing on the subject of the cheese trade in this State, it is customary to speak of the number of boxes instead of the number of pounds.

The only census from which it is possible to obtain the total production of cheese by counties is that of 1865. In that year the total product was 72,195,337 pounds. The same fourteen counties represented above gave 60,860,778 pounds, which was 84 per cent of the whole amount. Although this was thirty years ago, the relative proportion of cheese made in these counties is still as large as it was in 1865, or even somewhat larger. In the year 1892 the commissioner of

agriculture of New York directed the assistants of his department to make a full enumeration of the cheese and butter factories in the State, including their production during that year. The same work was done again in 1894, and the figures for the last-named year showed a marked falling off during the two years that had elapsed. The statistics of 1892 placed the total production in New York for that year at 131,148,310 pounds; those of 1894 placed it at 115,760,345 pounds, showing a decrease of nearly 12 per cent. At the same time the number of cheese factories in operation had decreased from 1,156 to 1,032, but the number of creameries, or establishments where both cheese and butter are made, increased from 213 to 315.

In the enumeration of 1892 the fourteen counties for which partial figures of the past season have already been given produced 113,533,012 pounds of cheese. This is $86\frac{1}{2}$ per cent of the whole, or $2\frac{1}{2}$ per cent more than it was found to be in the census of 1865, which shows that these counties had made a slight gain in the relative proportion of their manufacture of cheese. The proportion of these counties to the whole State in 1894 was 86 per cent, a difference of only one-half of 1 per cent, and as this was the year just previous to the one we are attempting to estimate, it seems best to accept this proportion as the basis of an estimate for 1895.

It has been shown that in 1895 portions of fourteen counties produced 990,000 boxes of cheese. If this amount forms 86 per cent of the whole, by adding the remaining 14 per cent, or 171,730 boxes, a total of 1,161,730 boxes is reached, equivalent to 69,703,800 pounds. This represents what may be called the known quantity. A sufficient amount must be added to represent the unknown quantity included in the partial estimates of some of the counties, the quiet purchases of home traders, and the consumption of producers themselves. The shrinkage of trade at the Utica board since the agricultural census of 1892 has been about 13 per cent; that of Little Falls is over 27 per cent. The receipts of cheese in New York City in 1892 were 1,999,029 boxes; in 1895 they were only 1,259,990 boxes, showing a decrease of 37 per cent. The receipts of 1894 were 1,613,385 boxes, and this shows a decrease in one year of 22 per cent. These few figures demonstrate the difficulty of forming any accurate judgment of the yield based upon incomplete returns. At the same time it is believed that if the total already named be considered as representing two-thirds of the yield of the State last year, it will come very near the correct figures, which would stand as follows:

	Pounds.
Two-thirds (closely estimated).....	69,703,800
One-third (approximated).....	34,851,900
Total	104,555,700

In confirmation of this, it has been seen that the decrease in production, as shown by the census of the State commissioner, amounted to about 6 per cent per year from 1892 to 1894. In 1895, however, the

drought was much more severe than in the two years previous, and the shrinkage must have been still more pronounced. If we allow 8 per cent decrease last year instead of 6, the total decrease since 1892 would be 20 per cent, and 20 per cent off 131,148,310 pounds brings it down to 104,918,648 pounds, which substantially agrees with the estimate given above.

STATISTICS OF EXPORTS AND IMPORTS OF CHEESE.

EXPORTS OF AMERICAN CHEESE.

In speaking of the exports of cheese, it has been thought best to use the figures for the whole United States rather than for the State of New York only, for two reasons: First, because the exports from New York City form such a large proportion of the total exports from this country; and, secondly, because the totals make the tale they have to tell more forcible and striking. To show the proportion of New York exports to those of the United States, the figures are herewith given for five years, from 1890 to 1894. They are taken from Assistant State Commissioner Van Valkenburgh's report, in which each year ends with the last of October.

Exports of American cheese, 1890-1894.

Year.	Exports.	
	From New York alone.	From all ports in the United States.
	<i>Pounds.</i>	<i>Pounds.</i>
1890.....	70,208,270	91,014,571
1891.....	61,299,205	77,148,794
1892.....	67,432,651	81,589,361
1893.....	53,293,060	67,925,712
1894.....	50,375,760	65,054,452

Taking these five years together, the proportion of the exports from New York to those of the whole country is a little over 79 per cent, and when we go back to the early years of exportation the proportion of New York is still greater. It seems evident, therefore, that whatever deductions may be drawn from the figures for the whole United States will also prove true of the exports from New York alone.

The statistics of our exports both of cheese and butter are much more satisfactory and available than those of production. Beginning with 1830, we have the exports for each year down to the present time, so that comparisons can easily be made. During the ten years from 1821 to 1830, inclusive, the entire volume of cheese exports was only 7,914,198 pounds. For the next ten years, to 1840, they were 8,247,795 pounds, an increase for the decade of only 333,597 pounds. But during the next decade there was an enormous increase, the business running up to 90,610,348 pounds, the exports of 1849 alone amounting to 17,430,000 pounds, or double the entire business of the 1830-1840 decade. It was a strange freak of trade, however, that the exports from 1850 to 1860 should fall off about 13 per cent and aggregate only 78,533,783 pounds.

In 1853 they ran down as low as 3,763,932 pounds, which was the lowest point they had touched in twenty years. And what makes it still more singular is the fact that this was during the first ten years after the introduction of the factory system. It is true that the system was on its trial during that period and made exceedingly slow progress, so much so that in 1860 only about a score of factories were in existence. Then, however, they increased so rapidly that in 1862 Mr. Willard enumerated 34 factories in Oneida County alone, and stated that Herkimer, Cortland, Jefferson, Lewis, and Otsego each possessed its own quota of factories.

In the year 1860 the exports rose from 7,103,323 pounds the year before to 15,515,799 pounds, and the next season to 32,361,428 pounds, and so on, with an irregular but pretty constant increase, until 1870-71, when the amount had risen to 63,698,867 pounds. The total for that decade was 446,512,816 pounds, an advance over the previous ten years of about 550 per cent. As a very large proportion of these exports went to Great Britain, it is reasonable that we should look for some cause for this enormous increase outside of the mere increase of manufacture in our own country.

Cause of increase.—It is believed that this may be found in Great Britain herself. In 1843 there was a duty imposed on cheese imported into that country of 5s. per hundredweight. In 1853 this duty was reduced to 2s. 6d. per hundredweight, and in 1859 the duty was abolished altogether. There is a striking coincidence, to say the least, between this fact and the doubling up of our own cheese exports in 1860, together with their continuous increase for the next ten years. By 1874-1875 our foreign trade in cheese had reached the hundred millions mark, and only once down to 1883 did it fall below that mark, and that occurred in 1875-76 when the exports receded 3,330,000 pounds. The decade from 1871 to 1880 came near reaching a thousand millions, the exact figures reported being 999,924,409 pounds. The exports of the years 1884 and 1885 exceeded a hundred millions each, but never since then have they reached that point. The figures are herewith presented in tabular form, and are for the commercial years as known to the cheese trade, including twelve months ending on the 30th of April of the years named.

Exports American cheese, 1881-1896.

Year.	Cheese exported.	Year.	Cheese exported.
	<i>Pounds.</i>		<i>Pounds.</i>
1881.....	147,995,614	1889.....	84,999,829
1882.....	127,989,782	1890.....	95,376,053
1883.....	99,220,467	1891.....	82,135,876
1884.....	112,869,575	1892.....	82,100,221
1885.....	111,992,990	1893.....	81,350,923
1886.....	91,877,235	1894.....	73,852,134
1887.....	81,255,994	1895.....	60,448,421
1888.....	88,008,458	1896.....	33,977,040

The flood tide of our exports occurred in the year 1880-81. Once before, in the year 1878-79, they rose to 141,654,474 pounds, but in

no other year did they reach 128,000,000. The really serious decline began in 1885-86, when the exports fell off 20,000,000 pounds, and amounted to slightly less than 92,000,000. The rally in 1889-90 came partly from a light make of cheese in England and a very heavy one in this country, and consequently lower prices than had been experienced since the season of 1879. For three years after that the exports remained about on the basis of those of 1887, but in 1894 they declined 7,500,000 pounds, and in 1895 they met with another decline of 13,400,000 pounds. The year just past, however, is far worse than any year since 1866, when the exports were 34,052,678 pounds, and it compares very closely with that.

Included in the amount of these exports are the cheese which go over the northern border of New York in the summer time to Montreal and thence to England. Ogdensburg is the principal point from which these exports are made, although the statistics of that office include all the stock which is shipped at Clayton and Alexandria Bay, as these two ports are in the Ogdensburg district. There are also small shipments made from Cape Vincent. The figures are as follows for the season of 1895:

Exports cheese via Canada.

Shipments from—	Pounds.	Value.
Ogdensburg	4,350,384	\$320,136
Cape Vincent	63,824	4,808
Total <i>a</i>	4,414,208	324,944

a In 1885 the writer obtained the figures of exports from these same ports. They amounted to 2,409,857 pounds for that year, showing that in ten years they have increased nearly 90 per cent.

This is all northern New York stock of the best quality, a large portion of it uncolored. It represents less than 5 per cent of the cheese manufactured in the State last year, but it also represents about 13 per cent, or one-eighth, of the entire exports of the country during the year 1895. A large proportion of the cheese made in northern New York is white; it is also acknowledged by dealers to be as fine as any produced in this country. For both of these reasons it is sought after by Canadian buyers, and the statement is made that considerable of it is branded "Canadian cheese" before being shipped to the old country. Unfortunately, this is considered a compliment to the stock, which no doubt sells better for being so branded; otherwise the brand would not be put upon it. At certain seasons of the year there is a lively competition for these goods between Montreal and New York, but when the market is active Montreal is liable to get the lion's share, on account of lower freight rates in that direction, which enable Montreal buyers to pay better prices than New York buyers can.

The causes of decrease.—The exports of cheese from this country are therefore down to a point which had been reached thirty-four years ago, when the factory system was comparatively new and there were

only about 400 factories in this State. There must certainly be some strong reasons for such a remarkable decline in the business within ten or twelve years. During that period the exports of Canadian cheese have increased almost as rapidly as ours have decreased, and the relative positions of the two countries have been almost exactly reversed. It may be well to see what was said about our cheese in 1866. Mr. X. A. Willard, who had been sent to England the year before by the American Dairymen's Association, to investigate the methods of manufacture there, said in the convention of 1866:

I have given them (English makers) the credit of producing a limited quantity of cheese of the finest type that has ever been reached by any manufacturer; but the quantity is comparatively small, and when the whole bulk is considered, there is nothing like the richness and uniformity of that from our factories.

Three years later, at the convention of 1869, Mr. John M. Webb, a New York dealer and exporter, related some of his experience abroad. He said:

During my visit to London last October, I went through a carefully selected stock of over 10,000 boxes of New York State cheese, with one of the largest and most experienced cheese factors in the south of England. The inspection was close and critical. When it was concluded, I asked two questions. The first was, "How do these cheeses compare with the English make of the current season?" Said this most competent authority, "The season has been so unfavorable that I don't think I could get returns of equal quality in all the south of England." I then asked, "How does the stock we have been looking through compare with the best English cheese of an average season?" The reply was, "They are just as good, and I did not think it possible to get together so many fine American cheeses."

Mr. Webb afterwards said that later in the season this cheese developed a lack of keeping quality, which seems to have been always one of the most serious faults with American cheese. These quotations, however, show that twenty-five or thirty years ago our cheese met many of the requirements of English dealers and consumers, and took the lead of all imported cheese in the English markets.

What has taken place since that time? The cheese trade of Canada can hardly be said to have made a beginning thirty years ago, while that of the United States was easily ten times as large as our neighbor's. In the year ending May 1, 1896, the proportion of exports is about 5 for Canada to 2 for the United States. Evidently there must be something radically wrong with the manufacture of our cheese to bring about such a change as this. It has been suggested that, on account of the frozen meats brought from Australia and South America to England and sold at lower prices than ever before, the consumption of cheese has declined in the latter country. There is undoubtedly some force in this argument, for we find that while the Canadian exports of cheese in 1894 were 1,726,058 boxes, which was the highest point they have ever attained, in 1895 they were 10,000 boxes less, thus showing a slight falling off there also. For the last three or four years the imports from Australasia have been a comparatively steady quantity,

and any small increase of these imports would do very little toward making up for the 400,000 boxes shortage in the imports from the United States in the year ending April 30, 1896.

It seems evident therefore that the consumption of cheese in England has materially decreased within a short period of time. The same thing has happened with pork. A recent English writer says:

It is generally considered that one of the chief causes of the low price of pork is the establishment in the country districts of shops for the sale of imported beef and mutton, which has been retailed at 3d. to 6d. per pound. A leg of 2-year-old wether mutton at 6d. per pound has been too great a temptation to countrymen, and the consumption of pork is not half as large as within recent years in the country districts for bacon-curing purposes.

Exactly the same thing may be said of cheese. The English countryman prefers to eat mutton rather than cheese, the price of both being the same. And that accounts in some measure at least for the decrease of 400,000 and odd boxes of cheese which the English imports showed last year.

But this is not the only reason nor the most serious one. As has already been said, there is something radically wrong with our cheese itself—something which has been gradually developing for several years past, but the effect of which was not fully appreciated until last season. As long as ten or twelve years ago the manufacture of "filled cheese" was being carried on in a small way by people in the Western States, where there were no prohibitory laws against it. In fact the article was originally made in New York at least as early as the year 1880. Several patents were issued to cover the special processes by which the cheese was made, and down to 1884 a lucrative business was carried on by the few establishments which had adopted its manufacture. But in the year 1884 the New York legislature passed a series of restrictive dairy laws, and created a dairy commissioner with a staff of officials to see that the laws were enforced. The men who owned the patents, as well as those who had been using them, at once conformed to the statutes, being law-abiding citizens, and no filled cheese has been made in the State since that time. But a year or two later the process was taken up in Illinois and then in Wisconsin, and its manufacture has been carried on with increasing volume. The result has been exceedingly disastrous to the cheese trade of the whole country. In two directions the sale of filled cheese has done harm to our dairy interests. One of these was abroad, the other was in the Southern States. It may be advisable to speak of these separately.

The injury done to our foreign trade by this product of skim milk and some foreign oleaginous substance to take the place of butter fat is not a new thing. It extends back for a number of years, and its results appear to be cumulative. When filled cheese was first sent abroad, it was not recognized as such. It went along with other goods which were the genuine article, and as no statement was made in regard to it, the receiver naturally accepted it as full cream, or, at least, as a

lightly skimmed cheese. So long as it was sold and eaten within a short period after its arrival, there was no suspicion of its genuineness. But after a while the stuff began to show its natural badness and to deteriorate very rapidly. Those who bought it lost money on it. This went on from season to season, and each year the English buyer became more and more suspicious of cheese from "The States." There was no guarantee of genuineness except the New York State brand, and not only did many of our State factorymen neglect to use this, but Western full creams could not be branded with it, while Western filled cheese often was branded with some inscription that was intended to convey the impression that the goods were not imitation, but genuine. This tended to discredit all cheese from this country, including that which carried the New York State brand. In the early winter of 1895 Wisconsin passed a prohibitive law in effect similar to that of New York. This removed her from the rank of counterfeiters, leaving Illinois to carry on the traffic alone. Canada had already seen her great opportunity and passed laws prohibiting the manufacture or sale not only of filled cheese, but of skimmed cheese also, and, in fact, of everything except full cream cheese, the pure product of cows' milk. This law has spiked our guns during the past year and rendered us comparatively helpless. Without it we might have divided the 400,000 boxes, of which the English imports are short. If our cheese had been all right, there can be little doubt that the decrease of consumption in England would have made a serious falling off in the Canadian exports as well as in our own. As it is, the English know Canadian cheese to be genuine, while all the United States product is more or less suspected; therefore they buy the Canadian in preference, and leave us to bear alone, practically, the whole of their decreased consumption.

IMPORTS OF FOREIGN CHEESE.

An analysis of the importations of cheese into this country may be of interest to the cheese maker. Previous to the year 1885 the importations of cheese, butter, and milk were all pooled together and only the total value of the whole was reported each year. But in 1885 the custom-house authorities began to report each of these articles by itself, and it will aid the reader in making comparisons to have the table of cheese importations before his eyes.

Imports of cheese, 1885-1895.

Year.	Cheese.	Value.	Year.	Cheese.	Value.
	<i>Pounds.</i>			<i>Pounds.</i>	
1885	6,247,560	\$964,587	1891	8,863,640	\$1,358,752
1886	6,309,124	855,570	1892	8,305,288	1,238,166
1887	6,592,192	874,261	1893	10,195,924	1,425,927
1888	8,750,185	1,214,936	1894	8,742,851	1,247,198
1889	8,207,026	1,135,184	1895	10,440,863	1,471,091
1890	9,263,573	1,295,506			

It should be said that down to 1895 these figures represent the even year from January to January, but in 1895 they are the imports from July 1, 1894, to June 30, 1895, which represents the fiscal year. For practical purposes, however, it is about the same. It will be seen that our imports have increased 67 per cent in the eleven years enumerated above, while our exports during the same period have diminished in just about the same proportion. At an average price of 8½ cents for the cheese sent abroad the past year the value of our exports is only as much again as the money paid out for imports. Nearly a million and a half of dollars was paid to foreign countries for cheese delicacies, a portion of which might be made at home if our dairymen and cheese makers would only do their work in the right and proper way.

In order to understand the situation more clearly, a special analysis of the imports for the year 1895 will be found useful. The following table gives the countries from which cheese was received, the number of pounds from each, and the value of the same in dollars:

Amount and value of importation of cheese for the year 1895, by countries.

Country.	Quantity.	Value.
	<i>Pounds.</i>	
United Kingdom.....	125,411	\$24,824
France.....	832,940	139,562
Germany.....	400,710	52,261
Italy.....	3,048,762	454,651
Netherlands.....	929,327	109,589
Switzerland.....	4,834,961	657,931
Other European countries.....	215,236	25,346
British North America.....	37,664	5,380
Other countries.....	15,852	1,547
Total.....	10,440,863	1,471,091

It will be seen at a glance that the importations from Switzerland and Italy comprise more than three-fourths of the whole amount, and that of the remainder the Netherlands contribute about 36 per cent and France about one-third. The cheese from France is principally Roquefort, Camembert, and Brie. Of these last two varieties we make a certain amount, but they do not compare favorably in quality with the foreign goods. The stock imported from the Netherlands is composed chiefly of Edams, although there are also a few Goudas. Some attempt has been made to produce Edams in Wisconsin, but it has not proved to be a success. So far as can be learned, there ought to be no serious obstacle to producing a fine quality of Edam in this country. There is a lucrative business awaiting the man who will resolutely set about making a choice article of Edam cheese in New York. It will require some capital and considerable patience, as the cheeses ought not to be marketed until they are three to five months old. But if they are made fine enough to sell for any such price as the foreign Edams bring their manufacture will pay a handsome profit. American switzer is made not only in New York, but in Ohio, Indiana, Michigan,

Wisconsin, West Virginia, and on the Pacific Coast. The product of Wisconsin is decidedly preferred to that of the other States by dealers in New York City. At the same time it is far from being equal to the imported Swiss cheese, as is shown by the prices at which it sells. The foreign article was sold by importers in the early winter of 1896 at 19 to 20 cents, while the same parties jobbed American switzer at 12 to 13 cents. There could be no such difference as this if there was anything like a parity in the quality of the two. Nearly 5,000,000 pounds of imported Swiss cheese is used in this country. The quantity made in the Western States is uncertain, although it is probable that Wisconsin produces about 1,250,000 pounds. It is a liberal estimate to put this manufacture in New York at 300,000 pounds, and that of the other States at 950,000 pounds. This would place the entire make of Swiss cheese in this country at 2,500,000 pounds, which is about one-half of the amount imported. It shows that there is a wide margin here for the improvement and extension of manufacture of this class of goods also.

The importations from Italy consist of seven varieties, viz: Romano, Reggiano, Parmesan, Gorgonzola, Caccio Cavallo, Formaggio di Bra, and Canestrato. Of these, the Romano is most largely imported, while Parmesan and Reggiano come next. Of the other four varieties only small quantities of such are brought over, three of them belonging to a class which may properly be called noncivilized cheese. The Romano variety is made from the milk of buffaloes, of which animal there is a species bred in central Italy much smaller than our bison. Their milk contains hardly any butter fat, and there would seem to be no great hindrance to the production of Romano cheese in this country out of skimmed milk, providing the correct method of manufacture was followed and the requisite time given for curing. But it is not probable that Parmesan cheese could be produced here successfully, as even the Swiss, who have tried it on the southern slopes of the Alps, have not been able to succeed. It seems to be a product peculiar to the plains of the Po and to the soil and pasturage belonging to that region.

Reggiano, which is made of full cream, is a mild and wholly civilized cheese, but requires long age to perfect it, inasmuch as it is never eaten less than a year old, and from that up to four years old. Its shape is that of a small-sized flat cheese made for home trade; but its exterior is black, though smooth, being rubbed occasionally with a preparation of lampblack and linseed oil to keep away flies during the long process of curing.

FANCY CHEESE.

DIFFERENT VARIETIES MADE IN THE STATE OF NEW YORK.

In addition to the ordinary styles of cheddar and flat cheese there is a considerable amount of "fancy" cheese made in this State. This includes the different varieties of foreign cheese, together with soft

cream cheese and what is known as "pineapple" cheese, which is a distinctly American variety. The principal varieties made here are as follows: Limburger, domestic Swiss, Münster, Brie, d'Isigny, Neufchâtel, Hand, Wiener, and Camembert. Limburger has been so successfully made in this country that the domestic article has practically superseded the foreign, and very little of the latter is now imported. One reason for this appears to be that Americans do not like the cheese as strong as foreigners want it. In this country it is put on the market and consumed when it is from 1 to 2 months old, at which age it has not acquired the very strong, rank flavor so much admired abroad. The Münster cheese is a milder and more solid form of the same class of goods. The Swiss cheese made in New York differs from the real Swiss in not having the gases so largely developed, and hence in being a more solid cheese and containing fewer and smaller holes. It is also marketed when only 3 to 4 months old, whereas the genuine Swiss cheese is kept in the curinghouse for eight or nine months, which allows it to develop a richer, more aromatic flavor. Here again, however, the American taste for a fresh and comparatively mild flavor in cheese is met by the domestic manufacturer. In the home-made Brie and d'Isigny this tendency is still more pronounced. Both of these varieties are sold at 2 to 4 weeks of age, when they are not much more than curd, and have hardly developed their distinctive qualities or have developed them in such a partial degree that they can hardly be classed as one thing or the other. The Hand Kase is a soft cheese, which needs to be marketed as soon as made, which is also the case with Wiener, Neufchâtel, and cream. Some of the domestic Camembert is said to be a fair substitute for the imported.

PRINCIPAL FACTORIES WHERE THEY ARE MADE.

There are three establishments for making fancy cheese in Orange County. The largest of these was established in 1873, and its principal business is in Neufchâtel and cream cheese, although it makes a little Fromage de Brie and d'Isigny. A Frenchman had come to the county and manufactured Neufchâtel some time before, but had not made a business success. The present proprietors bought out the interest of this pioneer and continued the enterprise. During the first year they used not more than 20 quarts of milk a day in the manufacture of the cheese, but gradually the business assumed larger proportions. Then a well-known New York firm sent for the senior proprietor and told him that they wanted for their trade a richer and more delicate cheese than anything to be found in the market and asked him if he could not devise something of that kind. After studying the subject for some time he produced the rich, soft, cream cheese which is now such a favorite among cheese lovers, and which has been so extensively copied and reproduced by other establishments. The origin of this variety of cheese should therefore be credited to Orange County and the establishment referred to. At first the Neufchâtel was packed in empty

starch, raisin, or soap boxes, which could be bought cheaply from grocers. These held from 112 to 248 cakes of the cheese, which were at that time simply rolled in tissue manila paper and packed in the boxes, with straw to fill the interstices. At length it occurred to the makers that it would be much better to have boxes made of the exact size to hold a certain number of cakes; so boxes holding 200, 150, and 100 cakes were tried, and it was very soon found that those holding 100 were most in demand. Then others were made to contain 50 cakes, and finally only 25, and with each change the business showed an increase. Along with the change in boxing came other improvements, such as substituting white parchment paper for manila, and outside of this tin foil stamped with a trade-mark and the name of the cheese. The same results followed these improvements as when ordinary factory cheese were first put into single boxes instead of casks—the neater appearance of the goods largely increased their sale.

The cheeses of this firm are sold in all the large cities of this country, from Boston to New Orleans. They even go to the Pacific Coast, and, what is stranger still, there is a steady and increasing demand for them in the island of Cuba. The war in Cuba does not seem to have caused any diminution in the sale of cheese there. The firm continues to ship weekly an average of more than 100 cases to the island. Ordinarily in the Eastern States the cheese is consumed within a few days after being made, and when asked if it did not acquire a sharp taste after a long voyage by sea or overland, the originator said he had never eaten it in the tropics, but had tried it in Western Oregon, and had found it all right there.

This establishment is very complete, and may be taken as the type for this class of manufacture. About 200,000 feet of lumber is used annually, the wood being cut and put up in shooks about 100 miles away. A printing machine has recently been purchased for putting the imprint on the outside of the boxes, which has hitherto been done with a stencil plate. With this the printing will be done directly upon the wood. The manufacturing rooms occupy the entire basement of the large building, and are floored throughout with stone. A 75-horsepower boiler runs the machinery. All the utensils and cloths are cleansed by steam. The curd, after draining as much as it will in the sinks, is put under powerful presses in bags, about a dozen under each press, of which there are long rows through the middle of one end of the basement. Of course large quantities of extra cream are used to enrich the cream cheese, and this is obtained by three large separators. The milk is put into the separators warm and fresh, but as the cream runs out it drips over a range of pipes filled with brine, and even in the warmest weather when the cream reaches the cans into which it drips it is cooled down to 36° or 38° F. The large curing rooms for hot weather are also cooled with brine pipes. The skim milk is all carried by gravity to a tank outside the building, and from that is forced up to another tank on a hill 3,500 feet away. There it is used for feeding hogs, of which

about 400 are kept continually in the pens. This is one of the profitable features of the establishment.

During the first winter this concern only used about 200 quarts of cream the whole season; now over 800 quarts of cream are used per diem. The total amount of milk used in the year 1895 was something over 3,250,000 quarts. Three millions of this was used in the manufacture of cheese, the rest in producing cream, which was sold in its natural condition. In round numbers, 6,000,000 pounds of milk was converted into cheese, the product of which would average 600,000 pounds of cheese. The low prices of Cheddar cheese in 1895 did not affect the price of soft cheeses to any considerable extent, nor does the season of the year affect them. From January to January they sell at the same prices. This system has its advantages and its disadvantages; for, should the New York price of milk average high, the manufacture of fancy cheese must be conducted at a loss, the milk being bought from the dairymen on the basis of prices at the New York city market.

The sale of fancy cheese is increasing rapidly, and the enormous falling off in our export of Cheddar cheese will, if it continues much longer, compel the factory men to enter upon some other branch of the business. While it is manifestly for the interest of this factory that the number of factories making soft cheese should continue to be limited, the proprietors can not help expressing the conviction that sooner or later our factory men will have to resort to the manufacture of a better article of Cheddar, or to a first-class butter, or to different varieties of cheese, in order to make a market for the milk.

Of the other two factories of a similar kind in Orange County, one makes only Brie and d'Isigny, and the other adds Camembert, Caprera Cream, Neufchâtel, Kümmel, Liederkranz, and Kappen cheese. The proprietors of both are native Swiss, and learned the art of cheese making in their own country. In the case of the older factory, its operators spent seventeen years in Normandy, France, where they perfected their knowledge of the Brie process. Coming to this country, they opened a factory for the production of foreign varieties of cheese, and for a time they made Camembert also, although recently they have given this up. They were the originators of the variety called "d'Isigny." When asked how they came to give it that name, they replied that, as Isigny butter was the best butter made in France, they desired to make their Fromage d'Isigny the best cheese in the United States. But as soon as the cheese began to acquire a reputation other makers imitated it and used the name, although it properly belonged to their manufacture only. At the World's Fair in Chicago their Brie, d'Isigny, and Camembert all took first prizes, and several of the leading hotels and most fashionable restaurants in New York City use their goods. The cheese is principally marketed in New York and Chicago. They hold their prices firm and do not change from year's end to year's end. They use in round numbers 1,160,000 pounds of milk yearly, which gives them a production of about 116,000 pounds of cheese.

Another factory is situated in the village of Monroe. This establishment is now managed by a Swiss maker, and produces a greater number of varieties of cheese than the other two factories. Its manufacture comprises Brie, d'Isigny, Camembert, Caprera Cream, Neufchâtel, Kümmel, Liederkrantz, and Kappen cheese. More of the two varieties first named are made than of the others, and in the winter season the racks are well filled with stock, ranging from perfectly new to 3 and 4 weeks old. They handle about the same amount of milk as the factory described above and produce about the same quantity of cheese annually.

Another large establishment of the same character, and one of the largest in the United States, is located in Jefferson County. At this factory are made Brie, d'Isigny, Camembert, Neufchâtel, Square Cream, Wiener, Münster, Limburger, Stilton, and in the summer time some American. The variety that is made in largest quantity is d'Isigny, and Neufchâtel comes next. Their goods are marketed in all the large cities of the United States. Most of them are sold at 20 to 30 days of age, except the Cream and Neufchâtel, which are shipped fresh. The factory handles about 15,000,000 pounds of milk annually, which in round numbers amounts to 1,500,000 pounds of cheese. The business increases from year to year, and the low prices of Cheddar cheese last season seemed to make little if any difference in the prices of their goods. Their plant is furnished with all sorts of machinery for doing the work and with every device for saving time and doing away with manual labor. The company has in its employ men from different parts of Europe who make special kinds of cheese by the same processes that are used abroad.

Still another is located in Chenango County and does a large business. Its headquarters are in New York City, where it does a large importing business also. The staple varieties of their manufacture are Neufchâtel, Philadelphia Cream, Saratoga Cream, Brie, and d'Isigny, besides which they make some Münster, Hand, English, and State factory cheese in summer when there is a surplus of milk. The manager of their factory turns out besides cheese a large amount of butter, which is unsalted, uncolored, and is put up in prints for the New York market. During the year 1895 the company received 3,470,516 pounds of milk, from which they manufactured the following amounts of cheese:

	Boxes.
English Dairy cheese.....	4, 230
Neufchâtel.....	28, 789
Philadelphia Cream.....	10, 625
Fromage de Brie.....	6, 272
Fromage d'Isigny.....	10, 927
Hand Kase.....	1, 800
Münster.....	950

Averaging the cheese at 10 pounds to the hundredweight of milk, the total cheese made by this company would be 347,051 pounds. The

name "Philadelphia Cream," for cheese, is secured to this establishment by copyright.

A cheese of peculiar size, shape, and appearance, and known as the Pineapple, is made in Wyoming County. This style originated with the family which still controls its manufacture. These cheeses are made in three sizes, viz, 2, 4, and 6 pounds, the larger size being put up four in a box, the others seven in a box. They are jobbed at \$2.75 per box. Last year was about an average season for the business, but prices were a trifle lower than before, being somewhat affected by the decline in Cheddar cheese. These goods are marketed in all the large cities of the land. Sixteen per cent of extra cream is added to the milk from which the cheese is made, thus creating a rich and delicate product that finds favor with many consumers. The cheese will keep perfectly for two or three years; hence there is no danger of loss to jobbers or retailers who handle it. The season of manufacture is from the first of April to the middle of November. About 1,000,000 pounds of milk were used by this firm last year, which produced 100,000 pounds of cheese.

Still another establishment which manufactures small cheese and English Dairy cheese that go through a special process and are cured much longer than our ordinary stock before being sent to market, is located at Gilbertsville, Otsego County, N. Y. The firm owns a dozen factories, scattered through different towns in that county, and their manufacture consists principally of fancy small cheeses of different sizes. Last year the production was as follows:

Styles.	Quantity.
	<i>Pounds.</i>
English Dairy, 19 pounds each.....	354,443
Table cheese, 4 pounds each.....	16,000
Fancy uncolored:	
10 and 20 pounds each.....	82,916
24 pounds each.....	246,735
Total.....	700,094

It takes the English Dairy cheese from five to six months to cure sufficiently to be put on the market. They are sold principally in New York, Boston, Philadelphia, and Baltimore. The Table cheese has to be cured about the same length of time. The smaller uncolored cheeses are ready for market in thirty days, and are made especially for New York customers. The larger uncolored fancy cheeses are made for the Boston market. These are made soft, and are ready for market at twenty days old. It is understood that a considerable proportion of the cheese which is sent to New York and Boston goes directly to private families, on orders, just as a good deal of the fancy butter made in private dairies is supplied to special customers. This is the most desirable trade to have, as it saves the commission of a middleman.

The total amount of fancy cheese annually manufactured by these seven establishments is about 3,500,000 pounds.

MANUFACTURE OF LIMBURGER, SWEITZER, AND MÜNSTER.

In addition to these special factories there is a considerable number of establishments in Oneida, Lewis, and Jefferson counties which manufacture Limburger, Swiss, Münster, and Stilton cheese exclusively. In the report of the New York State commissioner of agriculture for 1893, 57 of these factories are named, 2 of which, for the manufacture of Swiss cheese, are in Erie County. The total product of the 57 establishments in the year 1893 was 2,629,142 pounds, which was included in the sum total for that year already given, as was also the product of the other fancy cheese factories. Although there was very little diminution in the product of the latter last year, it is quite probable that the product of the Swiss and Limburger factories decreased last season in about the same ratio as that of the Cheddar factories, as they were subjected to the same climatic influences. The amount of Limburger produced is far in excess of all the other varieties put together, 40 factories making 2,003,070 pounds. There are, besides, 8 factories which made both Limburger and Swiss cheese, and these produced 181,256 pounds. The 6 factories that are devoted entirely to the production of Swiss cheese made 231,121 pounds. Five factories, which made Stilton and other fancy brands, produced 158,695 pounds, and the product of 2 factories in which only Münster is made was 55,000 pounds. Of course, the product of this whole business is small, being only a trifle over 2 per cent of the entire amount of cheese made in the State, or, counting in the other fancy cheese, about 6 per cent of the whole. There is, therefore, ample room for an increase in the production of fancy varieties, providing they are made sufficiently palatable to tempt the tastes of our own population. That must be the criterion for success. There are as yet no Edams made in this State, although, with the exception of Swiss and Italian cheese, the largest importation of any foreign variety consists of Edams. There is a clear field open for the maker who will produce this cheese of such a quality that it will compete with the importations from Holland. It is doubtful if Roquefort cheese can ever be successfully produced in this country, on account of the requirements for curing it, unless the time shall come when any variety may be reproduced by the introduction of the proper bacilli. Such a result seems to be the dream of the dairy bacteriologist of the present day.

While the amount of Brie cheese made in the State is comparatively large, it does not yet rival its French namesake in delicacy and palatability. Further improvement in its manufacture will doubtless create a greater demand and a wider market for it. Some of the Camembert made here is really good, but not yet equal to its foreign competitor. But for the production of any European variety with success, a special study must be made of our soil and grasses and of the conditions of our climate. Above all, our dairymen must learn to exercise the same care

and neatness in the treatment of their cows and milk that is found in the Swiss and Dutch dairies. In the countries which produce those fine varieties of cheese the cow stable is often an integral portion of the house and is kept with the same scrupulous neatness. Of course it is not necessary that our dairymen should build the house as an attachment to the stable, or should put the manure pile in the front yard, as is commonly done in continental countries, but it is necessary that they should keep the stables free from manure and from bad odors, that they should give clear, pure water to the cows, and that the cows and their udders should be kept as free as possible from manure or dirt of any kind.

An expert opinion on the requisite dairy work.—A member of one of the largest cheese importing houses in New York, himself in early life a practical cheese maker in Switzerland, when asked his opinion as to the manufacture of foreign varieties in this country, said it would be of great value to our dairymen, not more on account of the money to be made by it than for the special care it would require to be given to the cattle and to the general work of the dairy in order to produce fine qualities of cheese. It would have a tendency to compel the dairyman to take more rational care of his cattle and their food. Certain weeds in the pastures are very detrimental to the manufacture of such cheese, and they ought to be grubbed out as they are in European countries. The cows also should receive more attention than is customary in America, to obtain the largest possible quantity of milk and especially the finest quality. The manufacture of Yankee cheese requires less care, punctuality, and cleanliness in milking, and the firm buys its American Switzer from makers preferably of Swiss or Dutch birth and education. The Yankees are too careless. Swiss cheese has to undergo a long process of fermentation, and bad milk shows itself during this process and makes bad places in the cheese.

The main point in the above opinion is coming to be a vital one among cheese dairymen. The first requisite for making good cheese is clean and wholesome milk. This is the foundation of the dairy business, and until the farmers themselves appreciate this and strive to produce such milk, all efforts of the makers of cheese must be more or less ineffectual. A great deal has been said and written on cleanliness in the dairy, but when dairymen think of that subject they generally apply it to the utensils and receptacles of the milk and manufacturing rooms. It must, however, go back of all that and be applied to the external condition of the cow, to her daily surroundings, to the hands of the milker, and to the care taken in milking. The condition in which the bowl of a separator is left, after a mess of milk has passed through it, is enough to convince anyone who has seen and smelt of it that a mass of filth is to be found in average milk as it comes from the average milking stable. The average farmer is too apt to think that the factory man who insists upon having clean, untainted milk is a crank, and to neglect

the regulations prescribed by him for obtaining a pure article. But the truth is that our cheese will never reach the standard of European quality until this fundamental cleanliness in the care of the cow and the milking is understood and adopted by our dairymen.

DAIRY BOARDS OF TRADE IN THE STATE OF NEW YORK.

THEIR HISTORY AND PURPOSE.

Dairy boards of trade were first instituted in this country in the year 1871. The first meeting for the purpose of organizing such a board was held at Little Falls March 6, 1871, and the first sales day was May 1. Utica was next in the field, and made its first sales on May 29, while Sinclairville, Chautauqua County, came third, its sales day occurring on June 1. These three markets started within a single month, and Hon. X. A. Willard, of Little Falls, was the leading spirit both at that place and at Sinclairville.

The purpose of these organizations was primarily to help the dairymen. Previous to that time buyers often took advantage of the factory men, who were not as well informed on the markets as the buyers and might not know that an advance was taking place until several days after it had begun. By organizing into boards of trade and not selling cheese at the factories, but only at the weekly meetings of the boards, where the latest quotations were posted in plain sight, the factory men protected themselves against buyers who might be disposed to take advantage of them and were prepared to act with intelligence and in accordance with the latest news of the market. The popularity of these boards is evidenced by the fact that there is not a section in the State where a large cheese interest exists which has not some institution of the kind. At Canton, Watertown, Ogdensburg, Fulton, and Boonville, besides the places already named, regular organizations have been formed, while at Gouverneur, Norwich, Lowville, Cattaraugus, and Cuba a regular weekly market is held without any formal organization. The years when the regular boards were first established are as follows: Little Falls, Utica, and Sinclairville in 1871; Canton, 1876; Watertown, 1879; Ogdensburg, 1880; Fulton, about 1882; Boonville, 1894.

Utica has been the heaviest cheese market in the country from the start. There were two reasons for this: It could always be reached in a night by buyers from New York, and there was more full-cream cheese to be had there than at Little Falls. The transactions of 1871, the first year of the Utica market, were only 45,000 boxes. In 1873 they ran up to 100,000 boxes. In 1877 they had reached 210,713 boxes. The next year (1878) they were 322,535 boxes, but it was ten years before another hundred thousand had been added to this. In 1888 the transactions amounted to 409,564 boxes, although on account of lower prices the value of cheese sold was \$2,187,071, against \$2,415,581 the year before, when the sales were 22,000 boxes less. Even in 1889, when transactions reached the largest total ever known on that market, viz, 441,386 boxes,

the value of cheese sold was only \$2,294,500 because of still further shrinkage in prices. While therefore the heaviest transactions took place in 1889, the sales brought the largest amount of money in 1887. Since 1889 the amount of cheese marketed here has gradually shrunk away, until in the year 1895 it was only 218,545 boxes, which brings it down within about 8,000 boxes of the marketings in 1877. The average price also was so much lower than any other in the history of the board that the value of the cheese was only \$1,002,859, against a value of \$1,077,431 in 1876, the first year that values were reported, and when the transactions were only 167,355 boxes. One cause of the falling off in sales at Utica was the establishment of the board of trade at Boonville in 1894, which drew off about 40,000 boxes that were formerly marketed at Utica. Another cause that has operated increasingly for several years past was the building of milk stations (for city supply) on railroads running south from Utica, which took away a great deal of milk that was previously carried to cheese factories. These causes show that the heavy shrinkage of transactions at this market in the last six years is due only partially to a diminution in the production of cheese. Nearly all the milk, however, which is taken to the stations was formerly converted into cheese, and there is no doubt that even in a good year for feed the cheese production would now show a heavy decrease in comparison with that of 1890. Milk routes are gradually extending farther and farther into the interior of the State, and stations have been built in 1896 on roads that have never before carried milk. All this is of course a help to those who remain in the cheese dairying business, as it will leave just so much less of their product to be marketed and make it easier to dispose of. Generally speaking, all the milk that is taken to the stations and sold to go to New York, at least in cheese-making sections, has formerly been taken to the cheese factories and would go there now if it were not for this new outlet.

METHODS OF SALE AND SHIPMENT.

Nowadays cheese is never brought to the boards of trade when the factory men go to make their sales. Buyers know the factories by their reputation, and they often drive through the country to examine the cheese on the shelves. Besides, when they buy the cheese there is a tacit understanding, or sometimes a positive agreement, that the stock must come up to a certain standard in quality, especially when it is recommended and bought as first quality. When it arrives at its destination it is examined by an inspector, and if it is found to be inferior the factory is obliged to submit to a reduction in the price. Sometimes a few boxes only are not up to the standard; in this case these few are "rejected" and sold in open market for whatever price they will bring, and the factory bears whatever loss there may be on them. Cheese is shipped from the factory to any point the buyer may direct. If a buyer sells to a Western firm, or rather buys for one on an order, he directs

the cheese sent straight from the factory to that firm. When going to New York they are often shipped two or three days before the meeting of the board in the shipper's own name, and at the board the bill of lading is turned over to whatever buyer happens to take them.

CHEESE FACTORIES IN NEW YORK.

INTRODUCTION, INCREASE, AND PRESENT NUMBER.

The story of the introduction of cheese factories has been so often rehearsed that it is not necessary to repeat it here. But it may be desirable to note certain facts in relation to their increase and management that are not so well known outside of those dairymen who keep close watch of the statistics. It has already been stated that the first cheese factory was started by Jesse Williams in Oneida County in the year 1851. The advantages of such an establishment soon became apparent to dairymen who possessed the privilege of living near it, but the knowledge of these advantages was slow in spreading through the other States. In the report of the New York State Agricultural Society for 1862, Mr. Willard enumerates 34 cheese factories in Oneida County in 1861, ten years after their introduction, and says there are other factories in Herkimer, Cortland, Jefferson, and Lewis counties. At the same time, he says the system "has not been sufficiently tested to render it certain that it is to displace entirely the old methods." Under most of the censuses that have included dairy statistics, cheese factories and creameries have been put together, and the total number of the two combined has been given instead of the number of each separately. This makes it difficult to state what the number of cheese factories was in any particular year. According to Bulletin No. 1 of the Dairy Division of the Department of Agriculture at Washington, there were 269 factories in New York in 1864, 484 in 1865, 818 in 1870, and 1,018 in 1875. In 1880 the whole number of factories and creameries was 1,652, while in 1890 they seemed to have diminished to 1,337. In 1893 the State commissioner of agriculture made an enumeration which showed the existence of 1,156 factories and 213 creameries, a total of 1,369, or a small increase over 1890. Again in 1894 a similar enumeration was made, showing 1,032 factories and 311 creameries, or a total of 1,343, a diminution of 26, which brought the number down to within 6 of the number in 1890. These are the latest statistics taken, and as they stand it would appear that the whole number of establishments in which cheese was made was greater in the year 1880. This is no doubt correct, as our cheese production reached its highest point in 1881.

One of the State dairy laws in 1885 authorized the State commissioner to issue a brand for New York State Full Cream Cheese, and fixed a heavy penalty for its use on any cheese that was not full cream. The factories did not take up the use of this brand very readily, apparently for the reason that many of them made skim cheese in the fall,

and could not place the brand on this class of goods. Dealers, however, appreciated the value of the brand, and gradually came to make demands for it, so that in the year 1890 Commissioner Brown gave a list of 757 factories which had used it that season. In 1891 the number had risen to 796, but by 1894 it had decreased to 773. According to this latest enumeration, Cattaraugus County stands first, with 102 factories using the brand; Oneida County comes next, with 96, and Allegany third, with 91. Then follow, at a considerable distance behind, Lewis, with 69; Herkimer and Oswego each with 66, and Jefferson, with 63. Of the remaining cheese counties comparatively few use the brand.

SIZE OF FACTORIES.

There is a wide difference in the sizes of cheese factories. Some make only 5 or 6 cheeses a day; others make as many as 22 in the height of the season. A factory of average size will produce from 8 to 10 cheeses a day. Five cheeses a day would require about 3,000 pounds of milk. As a rule, the smallest factory would use the milk of about 150 cows; the average factory would take the milk of 300; while the largest would have the patronage of from 500 to 600. The number of patrons is so variable that it is impossible to give any idea concerning it that would be trustworthy. One farmer has 5 cows, while his neighbor may have 50. The larger dairies are more apt to go to the large factories, hence the number of patrons at a small factory is liable to be out of all proportion to the number contributing to a large factory. So the amount of cheese made in a cheddar factory ranges from 19,000 or 20,000 pounds in a season up to 220,000 pounds, or even more. An average factory will make from 36,000 to 40,000 pounds.

The location of patrons with regard to the distance from the factory varies from one-half mile to 3 miles. Generally they come within a radius of about $2\frac{1}{2}$ miles. The milk has to be delivered at the factory by 8 a. m., or sometimes earlier, and it is hardly feasible to do the milking and haul the milk more than three miles before that time in the morning. It is sometimes delivered twice a day, at morning and at night, and this trouble of hauling is regarded as one of the main items in deciding upon the location of a factory. It makes but little difference in the expense, however, as the farmer usually drives the milk to the factory himself and uses his own horses to do the hauling.

SYSTEM OF MANAGEMENT.

There is practically no difference in the system of factory management at the present time.

Originally the milk received at the pioneer factory was wholly purchased by the manufacturers, it being estimated and paid for by the amount of curd it produced when pressed. This was not satisfactory, so dairymen were left to accept a price for their milk or curd which the manufacturers felt safe in offering, or to allow them \$1 per hundredweight of cheese manufactured and the whey for performing the work

of making, curing, preparing for market, selling the cheese, receiving and disbursing the money, the dairyman paying all other expenses, as boxes, bandages, salt, rennet, etc.¹

Coming down to our own time, it is found that factory men receive \$1 per hundredweight for making, as they did thirty years ago, but for that sum furnish all the extras which are enumerated above as being paid for by the dairymen. The factory may be owned by a single proprietor or by a stock company, but the system of management is the same in either case. Generally a settlement is made with the patrons once in two weeks: Few factories in New York have as yet adopted the method of paying on the basis of fat contained in the milk, consequently each man is credited with the total weight of milk he brings, an average is made each time of the amount of milk it takes to make one pound of cheese, and the patron is paid in accordance with this average on the basis of the price per pound of the two sales of cheese put together. The average factory season runs from April 1 to November 1. Some of the large establishments run three or four weeks later but these are exceptions. After the factory has closed dairymen use their milk to make the winter supply of butter for themselves and their neighbors.

There is little difference in the practice of factories as to the length of time allowed for curing their cheese. It ranges from eighteen to twenty-five days, according to the season of the year. In the spring, when makers are anxious to get rid of their fodder cheese and to take advantage of the market before prices decline, it is shipped at eighteen to twenty days from the hoop. Later in the year it is held longer, in order to cure it better and give it safer keeping qualities. It used to be the custom with some factory men to hold their cheese in the fall and again take advantage of the higher prices that are apt to prevail late in the season. This is still done to some extent, but so many factory men have lost money on their cheese in the last two or three years by trying this experiment that it is not now practiced to the same extent as formerly.

FROM FACTORY TO TABLE.

Now let us take a piece of cheese at the factory and follow it till it reaches the hands of the consumer. Suppose it sells at a board of trade for $6\frac{1}{2}$ cents per pound. In a general way this may be calculated at 65 cents per 100 pounds of milk. In old times that amount of milk would make 10 pounds of cheese, although for a year past it has taken an average of about 105 pounds to make 10 pounds of cheese. This would deduct 1 cent per pound from the price obtained for the cheese as the cost of manufacturing, leaving 55 cents to the dairyman for his hundred-weight of milk. The wholesale cheese business has always been a very close one, and considering the amount of money used in it during a

¹ Report of American Dairymen's Association for 1864, p. 49. Paper by George Williams, son of the founder of the factory system.

year, the profits are probably smaller than in any other line of trade. The original buyer is very lucky if he gets a commission of one-eighth of a cent per pound. Freight from different points in the State to New York City varies somewhat with the distance, but an average of 25 cents per hundredweight will about cover it. This and the commission to buyer makes the cheese cost in New York City $6\frac{1}{8}$ cents. The merchant in that city expects to make a profit of one-fourth to three-eighths of a cent if the goods are sold soon after their purchase. This brings the price up to $7\frac{1}{4}$ cents, which the retailer has to pay. Then comes the charge which does so much to hinder the consumption of cheese in this country. Retailers are not content to take a moderate profit, but must have from 50 to 75 per cent advance on the cost of the goods. The common price of cheese at a grocery store, when it costs the retailer from $7\frac{1}{4}$ to $7\frac{1}{2}$ cents, is 14 cents per pound. In England, all through the season of 1895, cheese sold at 5d., or 10 cents, retail, and in 1896 it has sold there as low as $4\frac{1}{2}$ d., or 9 cents, per pound. When American grocery-men are willing to accept as moderate a profit on cheese as the English retailer, and sell it on the same plane as they sell butter, at an advance, say, of 20 to 25 per cent over cost, then we may expect to see the consumption largely increased; but so long as they persist in demanding such an enormous profit as they have done in the past, cheese will be looked upon as a luxury and only those will buy it who can afford to indulge in luxuries.

THE FUTURE OF THE AMERICAN CHEESE TRADE.

CAUSES OF DISCOURAGEMENT.

Canadian competition.—Certain features which militate against the cheese business in this country have already been mentioned, but there are others that may prove quite as serious. There is no doubt that Canada will continue to increase her make as long as she can find a market for the goods. If it were not for our duty on foreign cheese, the Canadian product would surely invade the States, for the reason that the dairymen of Canada live more economically than our dairymen and can afford to produce goods cheaper. Our duty on cheese protects us against this invasion, and the Canadians must therefore seek their markets in Great Britain and elsewhere. In order to do this most successfully, they are aware that their product must be hedged about with every restriction that will prove a guaranty of its genuineness. Their laws are framed with express reference to this guaranty, and the buyer is thus positively assured not only that Canadian cheese contains all the essential parts of the milk, but that it does not contain any foreign substance whatever. This legal requirement gives confidence in the cheese abroad and causes it to be sought in preference to stock from this country, of which so much has been adulterated that it is all looked upon with suspicion. One State has one law on the subject and another State has another law, while still another has none

at all. It has become self-evident that we must have a national law which will affect the whole cheese product alike, and it will place it on the same footing with that of our Canadian neighbors. With such a law in existence, it will be the fault of our dairymen and cheese makers themselves if their product does not meet with as ready sale as that of the Provinces. It is true that Canada has fostered this industry by large grants of money and by the creation of a department whose special business it is to see that every cheese maker in the Dominion is well instructed before he begins his work, and that he receives additional instruction each year to enable him to keep up with the march of improvement. In our country the States in which cheese is made have many other ways of using their money, and unfortunately too often prefer to appropriate it for purposes dictated by political partisanship. As a consequence, the majority of our cheese makers are too apt to go on in their old and often careless methods, with no one to instruct them or to suggest a better method. The exception to this is found in the case of "combinations" of factories. Here a number of factories are brought under the control of one man, the proprietor or a superintendent. He says to his makers, "I want all of our cheese to be uniform in quality, and in order to have them so they must all be made by the same rule and on the same plan. None of you can exercise independent judgment in this matter, but all must conform strictly to the instructions laid down by the company." By this means the combination avoids the rock upon which too many of the separate factories go to pieces. That rock is the idea of the maker that he knows as much as anyone else on the subject of cheese making and his unwillingness to try to learn even when he has the chance. Canada is one big combination under the direction of its thoroughly capable dairy commissioner. He lays down the rules and all the factories follow them; hence the excellence and uniformity of Canadian cheese.

Australasian competition.—But Canada is not our only competitor. For a number of years New Zealand has shipped a considerable amount of cheese to England, although it is understood that her product is not equal in quality to that of either Canada or the United States. In 1894, however, a more successful rival appeared in the shipments from Australia. For several seasons down to 1892 the Victoria government had paid a bounty to butter makers who exported their butter to the mother country, and having placed that industry on its feet, the government withdrew the bounty. Then a few cheese factories were established in the colony, and in 1894 a bounty of 6s. per hundredweight was placed on all cheese manufactured in the colony which could be proved to have brought the producer or exporter more than 50s. per hundredweight. In the spring of 1894 the first shipment of these goods arrived in London, consisting of 1,430 cases, 2 cheese in a case. These sold at 55 to 60s., at a time when Americans were selling at 59s. for the best, thus showing that the quality was

quite equal to our own. The American was of course old cheese at that time of the year, while the Victorian cheese was newer by several months, and in reality the former ought to have brought the best price in order to put the two on a par at the same age. Again last year Victorian stock was in evidence, but very little of it could have received the bounty, as American sold early in the season at 48s. and for a long time in the summer stood at 37s. 6d. to 38s. 6d., and Australian would probably command not much better prices. At the same time cheese can be produced in Victoria much cheaper than in this country. The climate is so mild that the farmers are not obliged to build cattle barns, but allow the cows to remain out the whole season and milk them for nine or ten months. In the early months of 1895 they received about 60 cents per 100 pounds for their milk, and it was said that under their favorable conditions they could produce it at 50 cents or less and still get a fair living out of the business. This is more than can be said of our own dairymen, who complain loudly if they are obliged to accept 60 cents, and who probably could not afford to produce it for that price under the present conditions of living. Australia and New Zealand sent upward of 4,000 tons of cheese to England in the early season of 1895, and they will probably continue to send increasing quantities in the present and subsequent years. This competition must therefore be met on an equal basis if we expect to continue sending cheese abroad.

The lessened exports.—The receipts of cheese at New York and the exports from that port tell the story of diminution in foreign demand. In 1890 the exports were 65 per cent of the receipts; in 1891 they were 63 per cent; in 1892, 67 per cent; in 1893, 60 per cent; in 1894, 67½ per cent, and in 1895, only 43 per cent. The prices in New York on May 1 in each of these years were as follows: In 1890, 11½ cents; in 1892, 10 cents; in 1893, 11 cents; in 1894, 10¾ cents; in 1895, 8 cents. The average price for the season on the Utica Board of Trade, which is the largest cheese market in the interior of the country, was as follows: 1890, 0.0842; 1891, 0.0888; 1892, 0.0933; 1893, 0.09647; 1894, 0.09465; 1895, 0.07648; and all this is in the face of a severely diminished production. Is it any wonder that our dairymen feel like throwing up the business and engaging in some other branch of agriculture? Is it not natural that they should ask, Where is our cheese to be marketed and what will be its price?

Weighed down by these unfavorable circumstances, as well as by the faulty manufacture of much of our own cheese and by the counterfeit stock that has flooded the foreign and Southern markets, is it any wonder that our dairymen feel disheartened at the enormous decrease in the volume of exports?

Filled cheese.—Within the last two or three years immense quantities of filled cheese have been shipped into nonproducing States, most of it with the label of "Full-cream cheese," but at prices just enough

below those of the genuine article to insure it a rapid sale. Quality being equally good, or, what is nearly the same thing until the facts are found out, appearances being equally good, the buyer will take those goods on which he can make the most money. And the filled-cheese makers have been exceedingly wise in their day and generation. They have studied carefully every point that would help the sale of their product. Their cheese are well boxed; they have perfectly level, smooth surfaces on top and bottom, with square and even edges; they are bright and handsome in color; they are made solid, and show good body under the trier. In all these respects filled-cheese makers set a good example to the makers of real cheese. They know that appearance has great influence in the sale of any kind of goods, and they have therefore made an exhaustive study of appearance, which it would be for the interest of makers of full cream cheese to imitate. But the crime of the filled-cheese men, for it is nothing less than a crime to destroy by unfair means a legitimate industry upon which hundreds of thousands of people depend for their support, is that they put their product on the market under a false name and sell it not for what it is but for what it is not. No fair-minded man would complain if filled cheese was branded with its real name and sold as such; but when it is branded as full cream cheese and used to fill contracts for that class of goods, every fair-minded man will declare that the law must step in to prevent such deception. At all events, it is the practice of this deception which has wrought such havoc with the trade in full cream cheese at the South and in far Western States. The imitation goods have taken the place of the genuine by means of assuming the name of the genuine and by being sold at a lower price. Thus the genuine has been crowded out of market even in a season of such light production as that of 1895.¹

The new law.—In the State of New York existing laws still further aggravate the situation by forbidding the saloons to offer free lunches, thus closing one of the largest agencies for the consumption of cheese. It is estimated that the saloons of Greater New York used from 8,000,000 to 12,000,000 pounds of cheese per year; and if those of the rest of the State be added to this it would bring the total consumption by means of free lunches up to at least 15,000,000 pounds, or about one-sixth of the total production of the State last year. This law is one of the severest blows yet inflicted on the cheese industry. Whether it will be permanent remains open to question. A repeal of this clause in the present law is not improbable, but it must stand during the year 1896 at least.

SOME GROUNDS FOR ENCOURAGEMENT.

And yet, with all these discouragements, the situation is far from being devoid of hopeful aspects. The question naturally arises, What

¹ It should be noted that this report was mainly prepared before the passage by Congress of the act approved June 6, 1896, requiring distinct branding of all filled cheese and placing special taxes upon its manufacture and sale.

must our dairymen and cheese factory men do to improve the conditions surrounding their industry? The first and most obvious thing to be done is to make better cheese, cheese which when brought into competition with the foreign will possess just as fine flavor and just as long-keeping qualities as that product. This is one of the self-evident propositions which it hardly seems necessary to spend any time in discussing. It is, however, a vital point, and must be looked after with all the ability, shrewdness, and skill that our makers can bring to bear upon it. With an equally fine quality of cheese, we can hope to compete with Canada in the markets of the Old World; without this quality, we shall eventually have to give up those markets altogether.

In the next place, our merchants must struggle to retain the markets of the South and West. The national law in the interests of pure food, which compels "filled" cheese to be plainly branded, will oblige the makers of that article to sell it on its merits only. This will necessitate their selling it at a much lower price if it is sold at all, and will destroy its rivalry with full cream cheese, under the name of which it has heretofore been marketed. The enforcement of this law ought to go a long way toward restoring the trade in genuine cheese throughout the South, which was almost ruined in the year 1895 by the sale of the counterfeit goods. The restoration of this class of home trade will materially help our cheese industry, particularly those establishments that make cheese weighing from 34 to 40 pounds.

A third suggestion for relieving cheese dairymen is that a portion of them should follow out the line hinted at on page 29. If the manufacture of cheese was more diversified, if a greater number of varieties were made, instead of confining the manufacture so largely to Cheddar cheese, there would be profit in it for those who made the varieties and relief for those who did not adopt that course. In the reports of fancy cheese factories it has been seen that the prices of their products were but little affected by the decline in Cheddar cheese. It may be said that this is because there are comparatively so few of them and the competition is so limited. There is probably some truth in this view of the matter, but it is also true that a choice, palatable article will always find a good market. The amount of fancy cheese sold shows that a fine, small-sized cheese is in demand, and these goods bring considerably higher prices than ordinary cheese. Most of it is so made that it possesses long-keeping quality, which is always an advantage, both to the maker and the merchant who deals in it. Besides, there is still room for other varieties, as it has been shown that considerable cheese is imported from foreign countries which might be made in this country, providing the requisite care and skill were exercised. The population of the United States is increasing with much greater rapidity than its dairy interests, and down to the time when filled cheese began to make such inroads upon the home trade the surplus cheese left by the gradual diminution of our foreign trade was being fairly well consumed by our own people. Even with the

enormous shrinkage in our exports last year (1895), which was much heavier than the shrinkage in our manufacture, the stocks of old cheese on hand in our markets in the spring of 1896 were smaller than they were a year before; it is a fair inference that, if our markets are not handicapped by filled cheese, the home consumption will be able to take care of a larger surplus than we had last year. With proper laws to protect the cheese industry against frauds, with greater variety in the styles of cheese made, and with an improvement in the quality of our goods, there is no good reason why our cheese dairies should not become as prosperous as they were before the disastrous season of 1895.

FACTORY CHEESE AND HOW IT IS MADE.

By G. MERRY,¹ of Verona, N. Y.

MODERN METHODS PRACTICED IN THE UNITED STATES.

The successful cheese maker considers good milk of paramount importance. For this he must depend upon the producers and his own watchfulness.

Handling milk.—The first step in the process of making cheese—the care and handling of the milk—devolves upon the farmer. If up to date, he must have a good herd of cows, treat them kindly, and provide them with plenty of clean, wholesome food and pure water. As the quality of milk depends much upon the management of the cow, pure milk may be expected from a well-cared-for dairy. After the milking is completed, the milk should be immediately taken from the stable and well aerated, or brought in contact with the air, either by running thinly over a flat or fluted surface, or passing from one vessel to another in fine streams or thin sheets. Milk should be aerated in a place where the air is fresh and pure, being free from stable or other objectionable odors. As the object is to remove the so-called animal odors from the milk, it would be useless to perform the work in an atmosphere laden with the same or worse smells than it is desired to expel. When delivery to the factory is but once a day, the night's milk, after being aerated, is cooled to 70° F. or less; this is necessary to insure the keeping quality of the milk and its arrival at the factory in good condition.

All cans, pails, strainers, and whatever utensils come in contact with the milk must be thoroughly washed with the aid of some cleanser, such as soap or salt, rinsed with boiling water or exposed to live steam, and placed where they will be thoroughly aired. By this means they are kept sweet and free from taint.

The milk is all delivered at the factory in the morning between the hours of 5 and 8 o'clock. The night and morning's milk should be brought separately, although it is sometimes mixed where the quantity supplied by a patron is small. The cheese maker knows it is his duty to receive no milk unless in proper condition. He stands at the receiving window, and by the use of his eyes and nose is able to detect any impure milk; all such must be absolutely rejected. He must have the experience and force of character to impartially perform this duty.

¹Mr. Merry is a practical cheese maker operating a factory at Verona, and has repeatedly won high prizes for his work. He has prepared this chapter by special request.

Upon the milk being accepted, it is poured into the receiving can, and a small sample is taken at this time for the fat test to be made later.

Sampling milk.—For sampling, a deep cylindrical cup holding about 1 ounce is used. This sample of milk is poured into a bottle large enough to hold 12 or 14 times such samples and bearing the number of the patron whose delivery of milk is sampled. One such bottle or jar is provided for every patron. A sample of each patron's milk is put into the proper bottle every day for ten days or more, and from this composite sample, as it is called, the test is made by the Babcock method of the fat contained in this patron's milk. A small amount of corrosive sublimate,¹—about as much as can be taken on the point of a common penknife—is put into the bottle previous to saving the first sample; this prevents the milk from souring and preserves it in a suitable condition for testing. After sampling, the milk is weighed and the patron credited with the number of pounds of milk he delivers. The milk is then run from the receiving can through a tin conductor into the storage vats. Each vat ordinarily holds about 5,000 pounds of milk.

Heating milk.—The temperature of the milk is then raised, heat being applied as follows: Between the wooden part of the vat and the tin lining there is an open space, which is filled with water; the water is heated by steam introduced through perforated pipes running in this space along the whole length of the vat. The warm water thus surrounding the tin lining of the vat gradually raises the temperature of the milk. The heating should begin while the vat is filling or as soon as filled, and should not be done too fast. After the required temperature of 82° F. to 86° F. is reached, the heating is stopped. The heating of the first vat usually begins at 6 o'clock or soon after, and all milk should arrive so the heating of the last lot may begin not later than 8 o'clock.

Determining ripeness.—The next step is to ascertain if the milk is in a condition ripe enough to add the rennet. Perhaps the most satisfactory method to determine the ripeness of the milk is the rennet test. The following specially prepared apparatus is necessary: An enameled cup, graduated on the inside, with a fine hole in the bottom, a pipette of 1 cubic centimeter, and a small bottle marked on the neck. With the pipette 1 cubic centimeter of rennet extract is measured into this bottle, which is then filled with water to the mark on the neck, not forgetting to rinse the pipette into the bottle. If the extract used be of standard strength, this will give a uniform solution at all times. The cup is then filled with milk and set on the edge of the vat. When enough milk has run from the cup to bring the surface of the milk down to the zero or first mark on the inside, the diluted rennet is quickly added, the whole stirred well, and the cup left undisturbed. The milk in the cup is closely watched, and as soon as coagulation takes

¹ Other substances, among them bichromate of potash and formaldehyde, having a similar effect, are also used as preservatives.

place it will stop running through the fine hole in the bottom of the cup. The graduation on the inside of the cup will show the amount of milk which has run out, and from this the maker knows the degree of ripeness which the milk has attained. This little operation requires some skill and experience.¹ The temperature of the milk and the strength of the rennet being always uniform, the variation in the amount of milk running from the cup before coagulation takes place will depend solely upon the degree of acidity of the milk.

When the milk is very sweet the ripening process is hastened by using a small quantity of clean sour milk, free from any taint. If this milk is thick, it is strained through a cloth so there will be no little lumps of loppered milk put into the vat. The milk should be so ripened that it will take from three and one-half to four hours from the time the rennet is added until the curd is ready to press. The degree of ripeness necessary to accomplish this result is only to be determined by experiment on the part of the maker. The condition of milk and degree of ripeness necessary will vary somewhat in different factories, and the cheese maker has to use his judgment at such times. When cheese is to be colored the coloring extract is put into the milk in the vat and well mixed in at least ten minutes before adding the rennet.

Handling the curd.—When, in the judgment of the maker, the milk is ready to proceed, sufficient rennet is added to coagulate the mass in about 30 minutes. The curd being set, it is ready to cut when it will break clean over the finger. For cutting the curd two forms of gang knives are used, a horizontal and a perpendicular knife, with blades about one-third to one-half inch apart. The curd is cut lengthwise and crosswise of the vat with each knife. This amount of cutting leaves the curd in cubes of about one-third of an inch on a side. The degree of fineness into which the curd must be cut depends on the ripeness of the milk, and is a matter which must be determined by the manner in which the moisture is expelled from the curd before the whey is drawn. It is usually about an hour and a half from the time heat is applied to the vat until the curd is cut. After cutting, the curd is gently agitated, to prevent it from settling to the bottom of the vat and matting together. The stirring allows the curd to shrink and expel the whey, or a portion of it. The kernel or small cube or lump of curd forms a thin skin or film over its surface, which prevents the fat globules and other cheese constituents from working out into the whey. The stirring of the curd after it is cut may be done by a hand tool called the curd rake. But a better factory appliance for this purpose is the "automatic curd agitator," which is attached to the vat and operated by steam. There are at least three different patterns of these agitators which do the work more satisfactorily than the hand

¹ This is known as the Marshall test, the simple apparatus being sold by dairy-supply houses.

rake. After stirring the curd for about ten minutes heat is applied again to the vat through its water jacket, slowly at first, as if heated too fast the pieces of curd would cook on the outside and thus hold in the whey. After a temperature of about 92° F. is secured the curd is heated faster until the required temperature of 97° to 100° F. is reached. This process, which is often called "cooking the curd," usually takes about one hour's time. During the heating process the curd is continually stirred and not allowed to get lumpy or to mat in the least. All the kernels must be kept separate to insure an even cooking. After the required temperature is reached the curd is still agitated for a few moments. The vat is then covered to assist in holding the curd at an even temperature until ready to draw the whey. If the heat drops it is again raised to the original temperature. It is important to know when the curd is cooked enough. This the cheese maker determines by taking a double handful and pressing together in his hands. If on removing one hand the curd readily falls apart it is cooked enough, otherwise it will be soft and hang together in a ball. When the curd will string about one-fourth to one-third of an inch on the hot iron the whey is drawn. The time occupied from the beginning of the cooking until the whey is drawn varies from two to four hours, averaging two and one-half to three hours.

In using the hot-iron test a small amount of curd is compressed in the hand until dry. This, when touched to a hot iron and slowly drawn away, will leave fine silky threads sticking to the iron if any acid has developed. The amount of acid is determined by the length of these strings. Any piece of bright, clean iron one-half inch in diameter and about 18 inches long will answer for this purpose.

After drawing the whey the curd is stirred somewhat and thrown up on each side of the vat. The vat is lowered at one end to make an incline to allow the whey to drain away from the curd. As the whey passes off and the curd becomes dry it becomes matted together and is then cut in pieces about 6 inches square and piled one on top of the other in one end of the vat. The curd is now turned as often as once in ten or fifteen minutes and piled in larger piles as fast as it will allow, always keeping in mind the fact that the surplus moisture must be expelled if we wish to make a good-keeping cheese. If curd is in a good condition it is kept warm by covering with a cloth and repiled occasionally. The curd soon becomes firm, and when a piece is taken in the hand it will feel velvety and pull apart in flakes. At this stage the curd will pull from three-fourths to 1½ inches on the hot iron. The curd is now ground and salted, using from 2 to 2½ pounds of salt to 1,000 pounds of milk. The salt is well stirred in and curd allowed to lie in the vat, with an occasional stirring, until salt is all dissolved and curd feels smooth and silky; it is then ready to press. The average time occupied from drawing the whey to this point is two hours, and from first heating the milk to the beginning of pressing the time is from five to six hours.

There are several kinds of mills for grinding curd. The one most commonly used consists of two cylinders covered with teeth and revolving toward each other, which pick the curd to pieces. The mill fits across the vat and the curd is ground through it into the vat.

The curd when ready for pressing is dipped from the vat with a flat-sided curd pail and put in the hoops, an equal amount being measured into each hoop. The hoops are immediately placed in the press and pressure applied.

There are several kinds of hoops, the most common sizes being the 14½ by 10 inch and the 13½ by 6 inch—that is, the hoops press cheese of those sizes. The bandage is put on an iron rim called a bandager, which slips into the top of the hoop and holds the bandage in place, with the lower edge of bandage turned in for about an inch on the bottom of the hoop, a cap cloth being first put in the bottom of the hoop.

There are times during the season, usually in the summer months, when curds have a tendency to be mushy, and will not become firm if piled. These curds are handled differently, being left in the whey longer—in fact as long as the maker deems it safe. The whey is then drawn and curd stirred thoroughly until it feels dry. It is then spread out over the vat, kept cool, and handled often in order to expel the moisture. When the curd becomes firm it is ground and salted, the salt thoroughly stirred in and the curd put in hoops and pressed at once. These curds if allowed to get mushy will make what is known as an oily cheese. The cause of this is found to be due mainly to a lack of the proper proportion of casein in the milk.

Pressing and curing.—The pressing of the cheese is done lightly at first and afterwards the pressure is gradually increased. After pressing about an hour the cheese is taken out and turned over in the hoops, the bandage carefully turned down and cap cloth put on smoothly. Pressure is then applied stronger and oftener until the limit of the press is reached. The cheeses are kept under the pressure for sixteen or eighteen hours, when they are taken out of the hoop and placed in the curing room. The cap cloths are left on the cheeses until they are ready for market.

The curing room is built with a wind-proof wall to guard against sudden changes in temperature, and provided with tight windows and blinds. The room is kept as nearly as possible at a temperature of 65° to 70° F., and should be well ventilated, so that the cheese may cure properly and have a clean flavor. The room should have tables, upon which the cheeses are turned and wiped. The cheeses, after being placed in the curing room, are turned over every morning and kept clean and free from mold and dirt; the tables are also wiped clean, using some canvas cloth for this purpose. The curing room is darkened during the day to keep it free from flies; in warm weather the windows and blinds are closed in the daytime to exclude the heat, and thrown open at night to cool the room. The cheeses remain in the curing room

on an average of three to four weeks. The conditions governing this variation in length of time are due to the differences in the manufacture of the cheese, temperature of curing room, and the state of the cheese market.

When ready for market, the cap cloths are removed from the cheeses and they are boxed; a scale board is placed in the bottom of each box and one on top of each cheese put in the box. The boxes are evenly trimmed to within one-eighth to one-fourth of an inch of the top of the cheeses and the cover put on. The official State brand is put on the top of both the cheese and the box, and the manufacturer's or factory brand is also usually put on the box.

The foregoing is a description of the latest improved methods practiced in factories in the State of New York, where cheese of the usual 60-pound Cheddar form and style is made, principally for export.

Cheese for home trade is made in the same way, except that the whey is drawn off as soon as the curd shows any acid by the hot-iron test. The curds are well matured in the vat and salted with about 2 pounds of salt for every 1,000 pounds of milk.

METHOD OF APPORTIONING DIVIDENDS UPON THE FAT-TEST BASIS.

The custom as to time of settlement for milk supplied by patrons varies somewhat with different factories. In most cases computations are made and settlements reached every two weeks, although some use monthly periods. Each settlement is made for a definite period of manufacture, and after the cheese made in that period has been cured, shipped, sold, and paid for.

The quantity of milk which each patron has delivered during the time included in any settlement is taken from the daily records. The test records for the same period give the average per cent of fat which the milk contained during the time, ascertained from fat tests of the composite samples. The total quantity of milk delivered, multiplied by the average per cent of fat, gives the number of pounds of fat delivered by the patron during the period considered. This is the basis for settlement. From the gross receipts for cheese sold for the period the expense of manufacturing is deducted and the net proceeds of sales are divided by the total number of pounds of fat delivered by all the patrons during that period; the quotient is the net amount for each pound of milk fat which has been realized by the sales of cheese. Each patron is to be paid at this rate for the number of pounds of fat contained in the milk furnished by him.

For illustration, take the examples following, to cover a period of one month: A delivers during the first ten days of the month 1,500 pounds of milk testing 3.2 per cent of fat; during the next ten days 1,700 pounds testing 3 per cent, and during the last ten days 1,600 pounds testing 3.1 per cent. B delivers during the first ten days 2,500 pounds of milk testing 3.6 per cent; the next ten days 2,700 pounds testing 3.5 per cent, and the last ten days 2,800 pounds testing 3.7 per cent. C

delivers 2,000 pounds testing 4 per cent the first ten days; 2,200 pounds testing 4.1 per cent the next ten days, and 2,400 pounds testing 4.2 per cent the last ten days. We find the total of milk delivered by all to be 19,400 pounds; total number of pounds of fat, 707.7. Supposing that from this milk 1,940 pounds of cheese was made, selling at 10 cents per pound, the following figures will be found upon the record books of the factory:

Gross receipts, 1,940 pounds of cheese, at 10 cents..... \$194.00
Deduct cost of making and furnishing cheese at \$1 per hundred weight.. 19.40

Net proceeds to be paid to patrons..... 174.60

\$174.60 divided by 707.7, the total pounds of fat, gives the net price per pound of fat to patrons as..... \$0.24671+
Average per cent of fat in all milks..... 3.64+
Number of pounds of milk to 1 pound of cheese..... 10

Settlements with individual patrons:

	Milk.		Fat.		Payment or divi- dend.
	Pounds.	Per cent.	Pounds.		
A:					
First 10 days.....	1,500	3.2	48		
Next 10 days.....	1,700	3	51		
Last 10 days.....	1,600	3.1	49.60		
	4,800		148.60, at \$0.24671		\$36.66
B:					
First 10 days.....	2,500	3.6	90		
Next 10 days.....	2,700	3.5	94.50		
Last 10 days.....	2,800	3.7	103.60		
	8,000		288.10, at .24671		71.08
C:					
First 10 days.....	2,000	4	80		
Next 10 days.....	2,200	4.1	90.20		
Last 10 days.....	2,400	4.2	100.80		
	6,600		271, at .24671		66.86
Total					174.60

A statement similar to the following is given monthly to every patron:

September dividend, 1895.

Mr. ——— A ———:

Number of pounds of milk received from your dairy during the above-named month, given in separate amounts, with per cent of fat in each, as shown by the Babcock test: $\left\{ \begin{array}{l} 1,500 \text{ pounds, } 3.2 \text{ per cent fat.} \\ 1,700 \text{ pounds, } 3.0 \text{ per cent fat.} \\ 1,600 \text{ pounds, } 3.1 \text{ per cent fat.} \end{array} \right.$

Total.....Milk, 4,800 pounds; fat, 148.60 pounds.
Average per cent of fat in all milks delivered at the factory during said month.....per cent.. 3.64+
Amount of milk required to make 1 pound of cured cheese during said month.....pounds.. 10
Average price per pound received for the cheese made during said month.. \$0.10
Net price per pound of fat..... \$0.24671
Amount of cash now paid to you, being in full for the milk delivered by you during said month, after deducting my charge of \$1 per 100 pounds for making the cheese and furnishing materials..... \$36.66

By this statement the patron can see how much he has delivered during each period covered by the sales, and the testing, and the per cent of fat in his milk during that period. He can also compare the per cent of fat in his milk with the average of all milks delivered at the factory during the month.

In changing from the old method of paying for all milk alike by its weight to the fat basis, the question was brought before our patrons at their regular annual meeting and thoroughly explained. The patrons had been informed some little time previous to the meeting of the intention of taking some action in the matter, and several of them had given thought and study to the new method and were prepared to discuss the question intelligently. After a thorough exchange of opinions a majority were in favor of adopting the new method.

During the first year of using the test the patrons made little objection to its use, preferring to give it a fair trial and note the effects. The conclusion reached by the patrons after this trial was clearly shown at the next annual meeting, when, with but a single objection, it was voted to continue the test method. At the present writing, after three years' practical use of the Babcock test, the patrons would not consent to a return to the old method.

The introduction of the fat basis has resulted in a general improvement of the interests of our factory and the patrons. The quality of the milk being an important factor in determining its value has led to a more systematic method of breeding. Almost every dairyman and patron is giving more thought to the principles governing breeding and is endeavoring to produce a herd giving a large amount of milk of the best quality. He also feels more interest in his work and consequently his milk is better cared for and delivered at the factory in better condition. The cheese maker is thus enabled to produce a finer quality of cheese and also to show an increase in the amount of cheese manufactured from every 100 pounds of milk.

This basis of settlement is certainly far more equitable as well as better, because of the results stated, than the one so long in use and still adhered to by many factories. Canadian authorities now claim, however, that it is not quite fair to depend upon the fat content of the milk alone, but that the casein should also be taken into consideration. More time and experience is necessary to consider this proposition for a further change in the basis of settlement with patrons.

APPENDIX

TABLES OF CHEESE PRODUCTION AND TRAFFIC.

No trustworthy record of receipts in the city of New York were made previous to 1865. Down to 1878 the record runs from January to January; but from May 1, 1877, the record began to be compiled from the opening of a new season in the receipt of goods, and Table No. I., is arranged accordingly.

TABLE NO. I.—*New York receipts of butter and cheese (in packages).*

Year.	Butter.	Cheese.	Year.	Butter.	Cheese.
1865	607,136	.....	1880	1,494,015	2,833,878
1866	493,061	742,441	1881	1,423,717	2,830,586
1867	551,791	1,302,132	1882	1,386,672	2,286,396
1868	502,906	1,136,584	1883	1,517,818	2,486,612
1869	645,195	1,335,522	1884	1,618,270	2,441,561
1870	552,973	1,495,969	1885	1,633,652	2,091,862
1871	480,767	1,331,250	1886	1,661,916	1,861,457
1872	473,351	1,542,972	1887	1,690,447	2,070,379
1873	689,761	1,809,689	1888	1,774,374	1,950,176
1874	995,430	2,036,468	1889	2,092,115	1,953,522
1875	1,080,899	2,322,331	1890	1,843,702	1,954,448
1876	1,292,577	2,171,617	1891	1,780,826	1,832,572
1877	1,269,759	2,420,601	1892	1,654,198	1,999,029
May 1, 1877, to May 1, 1878.	1,282,902	2,562,053	1893	1,711,466	1,551,468
1878	1,486,475	2,309,168	1894	1,708,576	1,613,385
1879	1,508,859	2,437,688	1895	1,923,061	1,259,990

TABLE NO. II.—*Transactions of the Utica Board of Trade.*

Year.	Number of boxes.	Value.	Average price per pound.	Range of prices.	Year.	Number of boxes.	Value.	Average price per pound.	Range of prices.
			<i>Cents.</i>	<i>Cents.</i>				<i>Cents.</i>	<i>Cents.</i>
1871	45,000	.....	.....	.....	1884	315,641	\$1,988,538	10.5	8 to 12
1872	75,000	.....	.....	.....	1885	320,796	1,531,150	7.955	5 10
1873	100,000	\$1,495,965	.....	.....	1886	325,962	1,773,885	9.07	6 12
1874	154,800	1,777,692	.....	11 1/2 to 16 1/2	1887	387,485	2,415,581	10.35	7 12
1875	160,320	1,735,592	12.5	10 1/2 15 1/2	1888	409,564	2,187,071	8.9	7 10
1876	167,355	1,077,431	11.1	8 1/2 14	1889	441,386	2,294,500	8.604	7 10
1877	210,713	1,425,877	11.67	8 1/2 15	1890	385,631	1,948,207	8.42	6 10
1878	322,535	.....	.....	6 1/2 12 1/2	1891	373,434	1,889,656	8.85	7 11
1879	301,550	1,488,555	8.227	3 1/2 13 1/2	1892	248,470	1,390,935	9.63	8 10
1880	298,827	2,085,573	11.632	6 1/2 14 1/2	1893	217,768	1,260,484	9.647	8 12
1881	240,746	1,615,184	11.1818	8 1/2 13 1/2	1894	273,896	1,555,455	9.465	7 11
1882	220,502	1,523,593	11.5161	10 1/2 13	1895	218,545	1,002,850	7.648	5 10
1883	264,628	2,025,201	10.8437	8 1/2 13 1/2	1896	190,038	895,649	7.855	5 10

TABLE NO. III.—*Transactions of the Little Falls Board of Trade.*

Year.	Number of boxes.	Value.	Average price per pound.	Range of prices.	Year.	Number of boxes.	Value.	Average price per pound.	Range of prices.
			<i>Cents.</i>	<i>Cents.</i>				<i>Cents.</i>	<i>Cents.</i>
1875	158,222	.....	12.5	10 1/2 to 16	1886	209,135	\$1,139,367	9.08	6 to 12 1/2
1876	177,273	.....	10.83	7 1/2 14	1887	229,017	1,514,106	10.36	7 13
1877	222,847	\$1,547,204	11.819	9 1/2 14 1/2	1888	239,085	1,245,093	8.95	7 11
1878	281,618	.....	.....	6 1/2 12 1/2	1889	265,224	1,337,776	8.7	7 10 1/2
1879	244,943	1,149,566	7.822	4 1/2 13 1/2	1890	245,059	1,181,836	8.36	6 1/2 10 1/2
1880	248,704	1,714,863	11.492	6 1/2 14 1/2	1891	236,249	1,202,788	8.55	7 11
1881	253,025	1,653,760	10.893	7 1/2 13	1892	206,058	1,218,662	9.15	7 12
1882	213,175	1,468,836	11.484	9 1/2 12 1/2	1893	197,865	1,100,337	9.5	8 12
1883	244,102	1,581,989	10.797	8 1/2 13 1/2	1894	202,028	1,088,474	9.096	7 1/2
1884	226,196	1,407,391	10.37	7 1/2 13	1895	150,207	714,684	7.93	6 1/2
1885	208,067	999,006	7.935	5 1/2 10 1/2	1896	120,754	564,259	7.788	6

TABLE NO. IV.—*Transactions of Watertown Board of Trade.*

Year.	Number of boxes.	Average price per pound.	Year.	Number of boxes.	Average price per pound.
		<i>Cents.</i>			<i>Cents.</i>
1879.....	50,813	7.195	1886.....	57,462	9.08
1880.....	60,291	11	1887.....	42,376	9.63
1881.....	55,961	9	1888.....	53,331	9.23
1882.....	56,807	10.08	1889.....	93,778	8.82
1883.....	65,201	10.288	1890.....	106,068	8.4
1884.....	94,373	9.09	1894.....	91,207	9.26
1885.....	47,988	7.75	1895.....	98,845	.....

TABLE NO. V.—*Production of cheese in New York State by counties (in pounds).*

County.	1845.	1850.	1855.	1860.	1865.	1870.	1893.	1894.
Allegany.....		1,145,391	1,044,978	939,115	104,374	220,880	8,543,800	6,914,154
Cattaraugus.....		1,382,963	1,717,484	1,857,349	.....	889,132	13,202,919	11,330,154
Chautauqua.....		2,271,890	1,198,361	1,153,257	782,257	773,830	3,201,027	2,669,873
Chenango.....		1,069,331	1,212,544	1,446,538	1,879,363	280,114	3,999,432	5,212,631
Erie.....		4,243,949	2,038,392	2,278,276	435,774	503,073	4,958,412	3,907,513
Herkimer.....	8,208,796	9,548,009	9,068,519	10,901,522	3,526,268	5,101,654	12,364,012	10,978,680
Jefferson.....	2,802,314	4,192,719	2,819,459	4,773,109	3,357,546	2,545,654	12,081,638	9,962,527
Lewis.....		3,067,309	1,896,741	2,911,775	3,171,721	977,547	8,694,944	8,353,399
Madison.....		.....	2,087,594	2,589,992	3,462,057	280,776	4,833,000	4,865,434
Oneida.....	3,277,750	5,218,734	3,311,114	3,519,732	8,107,018	1,228,459	13,067,442	11,794,297
Oswego.....		1,340,545	975,461	1,108,456	1,460,182	1,089,228	7,034,709	6,613,974
Otsego.....		2,049,673	1,638,493	2,161,929	1,559,591	829,439	7,094,850	6,109,465
St. Lawrence.....	1,281,972	1,596,450	1,672,999	2,353,887	322,615	1,710,082	14,730,278	11,502,880
Wyoming.....		1,007,359	823,105	981,946	446,011	709,935	5,148,340	3,605,072

NOTES.—The figures for 1865 represent only the cheese made in factories.

The figures for 1870 represent only the cheese made in private dairies.

According to the latest statistics these counties rank in the following order in regard to production: 1, Oneida; 2, St. Lawrence; 3, Cattaraugus; 4, Herkimer; 5, Jefferson; 6, Lewis; 7, Allegany; 8, Oswego; 9, Otsego; 10, Chenango; 11, Madison; 12, Erie; 13, Wyoming; 14, Chautauqua.



BULLETIN No. 16.

(Dairy No 7.)

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

THE DAIRY INDUSTRY

IN

NEBRASKA, SOUTH DAKOTA, AND NORTH DAKOTA.

BY

JOHN H. MONRAD,

SPECIAL EXPERT AGENT, DAIRY DIVISION.

Under the direction of

Dr. D. E. SALMON,

Chief of the Bureau of Animal Industry.



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1896.



LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., October 27, 1896.

SIR: I have the honor to transmit herewith a report upon the dairy industry in Nebraska, South Dakota, and North Dakota, prepared under the direction of Henry E. Alvord, Chief of the Dairy Division of this Bureau, and based upon reports by John H. Monrad, special expert agent of that Division, and to recommend its publication as a bulletin of this Bureau.

Very respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. J. STERLING MORTON,
Secretary of Agriculture.



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THE DAIRY INDUSTRY IN NEBRASKA, SOUTH DAKOTA, AND NORTH DAKOTA.

HISTORICAL.

The dairy industry in the States of Nebraska, South Dakota, and North Dakota is in a comparatively new and formative condition, as are large portions of the States themselves. But agencies have already been created for assisting in the development and improvement of dairying. Each of these three States has its organization for joint effort by those engaged in this branch of farming.

The Nebraska Dairymen's Association resulted from the enterprise of a few men, and started in the year 1885 with J. Dixon Avery as president and H. H. Wing as secretary. (The latter is now at the head of the dairy department of Cornell University.) This association held its eleventh annual convention at Lincoln in December, 1895. It is generally considered that the work of the organization has been effective and has decidedly raised the average quality of Nebraska butter. The State has recognized this usefulness by appropriating \$1,000 a year for the association, beginning with 1890. It is stipulated that at least 2,000 copies of the proceedings of the annual convention shall be printed and distributed. Particular activity has been shown by the association in recent years. It has provided for the expenses of a dairy speaker at a dozen or more farmers' institutes annually, has issued good reports, and also distributed circulars of information as occasion required. Much of this evident enterprise is credited to the present secretary, S. C. Bassett, of Gibbon, who is cordially supported in his good work by the president, E. F. Howe, of Crete, and by a wide-awake board of directors.

The South Dakota Dairy Association was organized in 1892, and held its fifth annual convention at Huron in January, 1896. The president is A. H. Wheaton, of Brookings, and the secretary, W. F. T. Bushnell, of Aberdeen. No State aid is yet given to the association, but the last annual meeting was well reported through the enterprise of the Dakota Farmer, of Aberdeen.

The North Dakota State Dairymen's Association held its second annual meeting in February, 1896, at Fargo. J. P. Power is president and E. E. Kaufman is secretary. The latter is dairy instructor at the State Agricultural College. Although in its infancy, this association has made a good start, and its proceedings have been published by the State department of agriculture and labor, whose head, A. H. Laughlin, is ex officio State dairy commissioner.

In all three States there have been farmers' institutes held for some years, and the dairy has been given fair consideration in the selection of topics for discussion. The State university and agricultural colleges encourage these meetings and furnish lecturers. They are also materially aided by the liberality of the railroads. The latter might well do more in this direction, as it is plainly in their own interest to foster any kind of educational meetings among the farmers. In Nebraska the institute work is well organized, although without State aid. In the Dakotas the work is not so systematically done and there is great room for improvement.

No dairy journal is published in any of these States, and none appear to be largely read among their farmers. The general agricultural papers give more or less attention to dairying, and a number of the county and local papers do likewise. There is opportunity for much usefulness through these channels, and it is suggested that the State dairy associations might accomplish great good by preparing weekly a column or so of well-selected dairy literature and distributing it to the local journals, which would, in nearly all cases, be glad to get this material and use it. The expense of such an undertaking would be moderate and would be fully justified by the missionary effect.

In the line of technical dairy instruction, the Dakotas are in advance of Nebraska. Lectures on dairying are given in connection with the agricultural course and the "short course" at the Nebraska State university at Lincoln, and these are accompanied by a few practical exercises. It is said to be the purpose of this institution to soon erect a dairy building and operate a small creamery. At the State college at Brookings, S. Dak., there is a neat little creamery in operation, and instruction, both theoretical and practical, is given in the making of butter and cheese. A cheese-curing room is a much-needed addition, and for this climate such a room should be built half under ground. The citizens and corporation of Fargo, N. Dak., contributed the funds necessary to build a commercial creamery in connection with the State agricultural college at that place. This is well managed and forms the basis for a yearly course of creamery instruction, and also a three months' course in the winter.

The conditions prevailing in all these States are such that much more good might be accomplished by perambulating dairy schools, operating a month in a place, after the plan successfully followed in

England, Ireland, and Belgium. The number of persons who might thus be instructed is very large as compared with the few who are able to attend the college courses, and the great need at present is to reach the isolated private dairymen or farm dairies and improve their methods. The creameries and factories can supply themselves with expert butter and cheese makers with comparative ease.

FARM DAIRYING AND CREAMERY PATRONS.

In Nebraska dairy farming has been well established in the eastern half of the State, and especially in the southeastern portion. It is also carried along the southern counties of the State almost as far as the eastern boundary of Colorado. An exceptional dairy district is found in some of the northwestern counties. There are comparatively few of the farmers as yet, however, who really make a specialty of this branch of agriculture. Most of them milk only 3 or 4 cows, or half a dozen at the most, and if they do not sell milk or cream their surplus butter generally goes to the local storekeepers in trade and finds its way largely to the "ladlers" or dealers in promiscuous butter. The latter report quite an improvement in the quality of farm dairy butter made in the State during the past ten years.

Sarpy County, on the eastern boundary of the State, is quite prominent in dairying. One tenth of the farmers are dairymen, keeping an average of 12 cows. Nine-tenths of these animals are grades and nearly one-tenth are of full blood. The milking period is nine months. The pastures consist of blue grass, timothy, and the native grasses of the prairie. Winter care and feeding is good and constantly improving. From 3,500 to 5,000 pounds of milk per cow is expected in the season. The milk is set in stone jars, tin pans, and deep cans; a few hand separators are used. The farmers find markets for their butter in Omaha and vicinity and sell to private customers at 20 and 25 cents a pound; some contract at 20 cents for the year. In a few cases 25 and 30 cents have been regularly paid for a superior article. The proximity of Omaha is the chief incentive to the dairy development in this county.

In Platte County, in the central eastern section, about one-fourth of the farmers make a specialty of dairying, and their herds average 20 to 25 cows. The pasturing season is for four or five months, and the stable feeding embraces ground corn and oats, hay, corn stover, and millet. Milk is generally deep set, and some separators are used. Swiss cheese and soft forms of cheese are made to a considerable extent in this county.

A little farther west, in Boone and Greeley counties, dairying is still a side issue and mainly confined to the vicinity of creameries. Farms will average about 5 cows, and these are milked not more than eight months. The pasturing season lasts five or six months, the natural

grasses of that region being excellent and the chief reliance. In winter, straw stacks and stalk fields replace the pastures, but some hay and grain are fed, and the building of several silos during 1895 indicates increased interest in dairying and a better appreciation of the efforts necessary to success. Most of the milk is produced between April and October, and there is little activity in winter. Jersey and Holstein blood is seen in the herds, but an annual milk production of 2,500 pounds is accepted as satisfactory. Deep setting of milk is practiced, and the butter produced sells at 7 to 15 cents per pound.

In the southern and southeastern part of the State, in the counties from Adams to Jefferson, only 5 per cent of the farmers are reported as engaged in dairying. These keep from 5 to 10 cows to a farm. Two acres are represented as carrying a cow, on natural pasture, but an estimate of 3 acres to a cow seems more general and reliable. The pasturing season runs through six months, if not uncommonly dry, and the cows are milked only seven or eight months. Winter care is poor, with little feeding except at stacks. Yet one farmer who has improved stock says he is able, by soiling, to make 1 acre support a cow, and he adds: "My experience in Nebraska is that if one keeps good cows and feeds them well they are as profitable as in any other State."

Personal observation appears to justify this last opinion, at least for the counties of Nebraska lying east of Adams. But it seems necessary to resort to soiling, more or less, for satisfactory results, and more use should be made of alfalfa, if it will grow as indicated by numerous trials. The dry seasons to which this region is more or less subjected kill off the tame pastures badly, and it is very unwise to break up the native prairie sod unless one is prepared to resort mainly to soiling as a substitute.

The conditions applying to Adams County, as above, and to Webster, immediately south of it, also apply to the double tier of counties extending westward from these along the southern border, at least halfway across the State.

Some exceptional conditions are reported from northwestern counties, especially Boone and Sheridan. This region was settled in 1885 and continuous wheat growing was practiced until stopped by droughts and low prices. Now about half the farmers keep cows, from 2 to 6 or 8, possibly averaging 6. A few herds are reported of 15 to 20 cows each. Most of the cows are grade Shorthorns, and they are milked eight or ten months, although they have fresh pasture only about five months. The feed consists of the native buffalo and other grasses, which cure upon the ground, so that a sort of unharvested hay is available in the fields or on the range during most of the winter. If covered with snow, hay, cornstalks, and perhaps a little grain are fed under sheds. Deep setting is the prevailing way for handling the milk, and 150 pounds of butter in a year is a usual product per cow. Some of this butter finds

special markets at 15 to 25 cents per pound, but much the greater part of it is traded at stores and shipped to the ladlers.

Private dairymen all over the State are gradually improving in the care taken of their milk, and hence the quality of its product. The same is true of those who sell to the creameries. The use of deep-setting methods is becoming general, but there is room for much improvement in detail. For cooling milk, tanks have to be generally depended upon, into which water is lifted by wind or other power. In many cases the water enters the tank near the top, on one side, and the outlet or overflow is just opposite; this develops very little motion of the water in the tank. The inlet pipe should open at the bottom of the tank, to insure full benefit from the fresh, cool water. Where wind is depended upon to change the water and fails, the tanks are too often neglected. The handling and ripening of the cream does not seem to be as well understood as the cooling. As said before, there is evident need of missionary work with good dairy literature or an itinerant dairy school.

Cheese making on farms is practiced more or less, but it is difficult to obtain any reliable data on the subject. The secretary of the State association estimates that something over half a million pounds were made in 1895. This would indicate that about 150 farmers make cheese at home, from an average of 13 or 14 cows each. The most important need in this work is knowledge of the correct construction and management of a curing room.

In South Dakota the conditions are much the same as in Nebraska, and it is needless to give reports received from different counties, in detail. Dairying has been developed mainly in the eastern half of the State. There are a few experienced dairymen doing good work, but most of the milk is produced by farmers who keep a few cows apiece, simply as incident to their general business.

As an example of what it is possible to do in the way of farm cheese making in this State, the following is copied from a recently published letter from the owners of a dairy at Ordway:

Our prairie hay is considered very nutritious and it is certain our stock does well on it. We raise considerable grain of one kind and another, but, except as that helps out our feeding, we find that stock raising and dairying pay better. During the year 1895 we made from 27 grade Holstein cows 15,250 pounds of cheese, or an average of 565 pounds per cow. This was cured in a temperature of 65° to 70° F., and sold to realize 9½ cents net per pound. We raise all our good calves, feeding them after 1 month old on whey, to which is added wheat bran and middlings or bran and barley meal.

The following table of reports from creamery patrons in South Dakota was recently compiled and published by the Dakota Farmer:

Reports received from farmers in South Dakota.

Post-office.	Number of cows milked.	Number of months covered by report.	Total amount received for cream.	Average per cow per month.	Per cent of fat in test of milk, average.	Number of calves dropped during time of report.	Value of calves dropped during time of report.	Are reports encouraging?	Number of cows will milk next year.
Aberdeen ¹	7	12	\$285.19	\$3.40	3.7	6	\$35.00	Yes...	10
Esmond ²	24	5	200.00	2.00	4.4			Yes...	31
Huron ³	12	7	325.75	3.87		12	50.00	Yes...	20
Huron	12	9	305.00	2.82	3.9	12	120.00	Yes...	21
Huron ⁴	21	9	425.86	2.25	3.7	21	189.00	Yes...	21
Huron ⁵	22	9	538.53	2.45	3.8	16	100.00	Yes...	30
Huron ⁶	10	7	197.44	2.82	4	6	36.00	Yes...	20
Iroquois ⁷	9	12	182.03	1.60	4.2	9	72.00	Yes...	12
Iroquois ⁸	12	12	382.12	2.65	4.1	12	96.00	Yes...	18
Kidder ⁹	12	9	324.00	3.00	4.3	12	120.00	Yes...	30
Lake Preston ¹⁰	5	2	52.69	5.22	4.4	3	27.00	Yes...	15
Millbank ¹¹	10	12		3.50	4	10	40.00	Yes...	10
Wankonda	5	7	103.00	2.91	4	6	55.00	Yes...	6
Do.	4	7	67.00	2.40	3.9	1	3.00	Yes...	6
Madison	6	8	180.54	3.76					
Do.	6	6	102.06	2.83					
Do.	8	12	298.93	3.11					
Do.	12	12	275.07	1.92					
Do.	13	12	423.65	2.72					
Do.	2	4	42.89	5.36					
Do.	7	12	167.21	2.00					
Do.	4	10	113.36	2.83					
Do.	4	12	155.20	3.21					

REMARKS.

¹ I did not milk over six at any one time during the year.

² Cows are strippers; am expecting new milkers soon.

³ I consider the creamery business the best of any occupation.

⁴ Huron creamery now getting 49,000 pounds milk per week.

⁵ Received an 1 fed to hogs about \$25 worth of skim milk.

⁶ Think the farmers of Beadle County are on the way to prosperity.

⁷ Cows had nothing but hay the whole year; will feed grain next.

⁸ These were just ordinary cows and cost not more than \$15 each.

⁹ Dairy business paid me more cash than did 500 acres of wheat.

¹⁰ Want 25 cows as soon as can get them; had none come in early.

¹¹ Our cows have averaged \$40 per year, and that is good.

In North Dakota the same state of affairs has been observed and reported. The greatest dairy activity prevails in the counties of Cass, Grand Forks, Dickey, Ransom, and Sargent. The usual milking period is seven months, and of these four are passed on pasture. The bulk of milk is produced during May, June, and July, and the average yield for the year is 3,000 pounds per cow. Private dairies generally practice the deep setting of milk, in water, pumped into tanks. Butter is largely sold to customers in the neighborhood or within easy reach, in 5 and 10 pound jars, at 20 cents a pound in summer and 25 cents in winter. There is a considerable quantity, however, which goes to the storekeepers at less than 10 cents a pound and is shipped out of the State to be ladled.

The reason for so much of this butter going to the questionable object is its very poor quality and condition from the time it leaves the

farms where made. It is not even good enough for the local demand, which still exceeds the supply in many sections of the State. Thus the farmers lose their home markets and get but half price for their product, because they will not learn to make better butter, take proper care of it, and make it in a rational way.

Active measures should be taken by the dairy associations in these three States to improve the quality of farm-made butter and stop the heavy loss resulting from the large contributions from these States to the supply of "ladled." The creameries are doing a good work in their way, but for years to come there will be farmers who can not well be creamery patrons, and these need all the help that can be given them. Attention may well be called to the work which several States, notably New York and Wisconsin, are doing to improve the grade of dairy products from the farms as well as from the factories. This same line of work is still better organized and conducted in Canada, with apparent and gratifying results.

LADLED BUTTER.

In all parts of the country where butter is made by small farmers at their homes, more or less of it is disposed of at the country and village stores. Of this, the condition of a considerable part is such that the merchants can not sell it to their retail customers. These numerous small lots of poor, damaged, and thoroughly bad butter have to be disposed of as grease or go to establishments which gather large quantities of the material and so manipulate and "renovate" it as to bring it into a merchantable form as a food product. In the butter market quotations these goods are called "ladles."

The newer dairying districts produce immense quantities of this class of butter, or that which, after treatment, comes to be thus known, and the largest establishments for handling this material are in the Northwest. One or two are located in Nebraska. There are none yet in the Dakotas, and the ladle butter from those States is at present sent to Minnesota and Iowa factories for renovation; some of it to Chicago.

It is impossible to determine with any accuracy the quantity of this low-grade dairy butter made in the three States under consideration which is contributed to the ladle-goods business. The rapid increase in the number of creameries tends to reduce this business, but farm dairies seem to be multiplying with equal rapidity, thus maintaining the supply. A careful canvass of the larger firms and their courteous replies to inquiries has enabled the following estimate to be made, and it is considered approximately correct:

Ladled butter produced in the year 1895 from the States named.

	Pounds.
Nebraska	7,400,000
South Dakota	1,300,000
North Dakota	500,000
Total	9,200,000

Not included in this estimate is the butter shipped from these States to lard factories east of the Mississippi River and that which, originally shipped out of the States where made as private dairy butter of fair grade, finally finds its way to the larders.

This business is carried on as follows: The local storekeepers take butter in exchange for goods. The price allowed all producers at any one store is the same, quite regardless of the quality of the butter; it is necessary to treat all the farmers alike. As a rule, merchants sell what they can of the best received, without any profit or at an advance of 1 or 2 cents. The remainder, which in most cases constitutes much the greater part of the receipts, is dumped into receptacles of all kinds, and periodically sent off to the centers for larding. Flour barrels, starch boxes, shoe boxes, and soap boxes have been indiscriminately utilized for this purpose. Much of this so-called butter is of such character that it makes little difference how it is neglected. The carelessness and indifference shown in some places is shocking. The receptacles are left open, no attention paid to the mixed contents, and they are not sent away until full, or until the mixture becomes so offensive that it must be got rid of. The one requirement of the package has been that it should not leak and waste too much, if the contents melted to oil in transit. Economical motives alone seem to have led to a reform in this regard. The larders now send out what are called butter stands to their regular sources of supply. These are large oak tubs or barrels, generally somewhat conical, with large bottoms to prevent overturning, tight covers, and strong handles. These are shipped to the factory when filled at the store. The contents of some of these tubs upon arriving at the larding establishment is simply indescribable; the many small lots of butter—as the material was probably at one time entitled to this name—differ in color, salt, texture, age, and other respects, and sometimes the tubs contain articles quite foreign to the dairy, like bacon rind and mutton-chop bones. In cold weather it is possible to measurably separate and sort the different lots; in hot weather it is simply a mass of grease, not sufficiently melted to be homogeneous, but so far advanced as to make it impossible to vouch for all being originally butter fat.

The larders receive this material, grade it as best they can, and make their own returns to the shippers, as to both weight and quality. During the season of 1895, the average price paid by larders for shipments from these three States, was just about 10 cents per pound, the shippers paying freight to Omaha, or wherever the factory was located. Freight charges probably averaged half a cent a pound.

There are efforts in progress on the part of larders to improve the quality of their product by securing some degree of care in the collection and transportation of the country butter. Merchants are encouraged to hire collectors to get the butter from the farms, uncolored and

unsalted. The following circular letter from one of the ladling concerns further explains this business:

MAY 8, 1895.

GENTLEMEN: We ask your attention to this circular regarding the handling of butter during the summer months. The low price of butter on the Eastern as well as the Western markets warns us to use every effort possible to turn out a better grade of butter than ever before, for this reason: The butter market has come to that point where the quality governs the price; much of the poor butter is caused by improper handling, and we offer a few simple yet valuable suggestions which we ask you to carefully consider.

(1) When you receive butter from the farmers keep the good butter separate from the poor.

(2) Keep your butter in a cool place, free from all odors of any kind.

(3) Don't hold your butter longer than necessary to get a shipment, for every day you hold injures the quality of the butter and consequently reduces the price.

If you send us good, fresh stock you are sure to get the highest price in return, and a trial shipment of butter will convince you that we mean business and will follow out the principles of this circular to a letter. We are in business to stay, and as our reputation is at stake we feel it is for our best interests to give our shippers, one and all, a square deal, top price, and prompt returns every time. At present, regardless of the low price of butter East and West, we quote you the following cash price f. o. b. your station: Good, fresh butter, per pound, 8 cents; poor butter, per pound, 6 cents.

Our butter stands we furnish free, but parties shipping to other buyers our stands will be charged \$1 for each stand.

Thanking you for past favors, and hoping to receive a continuance of your patronage, we remain,

Yours, truly,

The profit of the ladlers lies in intelligent grading and increase in weight by salting, washing, and reworking; also, more or less, in the success of the various processes used in eliminating rancidity, and restoring the semblance of grain and flavor to the mass. The article resulting is called butter and goes into the butter market, but it may well be doubted whether, as a food product, it is as good as average butterine. As a rule, "ladles" are quoted in the Chicago market at about two-thirds the price of creamery butter and about four-fifths the price of dairy butter of like grade, "extras," "firsts," or "seconds." What is known as "imitation creamery" is, as a rule, nothing but selections of the best of the ladled goods.

There is no intention of fully describing here the processes of ladling at the establishments built for that purpose. These processes differ a good deal and involve both mechanical and chemical treatment of the butter. The present purpose is to call attention to the large quantity of farm-made butter which goes through this mill and takes this low grade, which ought to yield the producers half as much again, and perhaps twice as much, and would do so if the right methods of manufacture were adopted. The extension of the creamery system is probably the surest and the quickest way of correcting the evil. But much farm-to-farm teaching of the elementary principles of caring for milk and of making and marketing butter is needed.

CREAMERIES.

With a view to making a report upon the creameries of Nebraska, South Dakota, and North Dakota, and upon their work, without spending too much time in personal inspection, blank forms were prepared and distributed in the hope of thus securing the main facts, which might then be summarized. The most accurate lists obtainable of these establishments in the States named were used, but the result, as given in the following table, shows the difficulties attending such an effort and the uncertain value of the information thus obtained.

Number of blanks sent and replies received from creameries and cheese factories.

State.	Blanks sent.	Returned unde- livered.	Supposed to be delivered.	Replies received.	Per cent of replies.	Remarks.
Nebraska	145	24	121	29	23	Two cheese factories. ¹
South Dakota	108	17	91	27	30	Two cheese factories. ¹
North Dakota	28	0	28	9	32	One cheese factory. ¹
Total	281	41	240	65	27	

¹ Included because so few.

Replies having been received from only one-fourth of the factories believed to be in operation at the time, it is manifestly useless to tabulate the returns for use in a statistical way. But assuming that the reports received were from representative establishments, they form, in connection with notes taken at the creameries which it was possible to visit, a reasonably satisfactory basis for sundry remarks and suggestions.

Nebraska has suffered from three successive seasons of extreme drought. Yet in comparing results with other States, her creameries appear to be able to do about as well, in rates of payment to patrons, as the northwestern dairying regions in general. And this, too, notwithstanding the frequent necessity for long hauls to the creameries, and consequent increase in the cost of manufacture. The farmers in this State who have been turning their attention to dairying, as creamery patrons, have done better in fact than they appear willing to acknowledge in conversation. Claiming that they had no time to milk cows, that they had unreliable pastures, and that they ought to let cows alone and cultivate their farms—it was easily proved, and often finally admitted, that the cows paid better than the crops, and during these trying years they would have starved, had it not been for the sales of milk, cream, and eggs.

It is evident here, as in most parts of the West, that the farmers spread their labor over too many acres of land. Better attention to smaller areas under cultivation and the provision of fodder crops to help out dry pastures would rapidly improve the condition of most of those visited.

The creamery buildings in the State are of varied quality and capacity—good, bad, and indifferent. The gathered-cream plan was unfortunately adopted very largely at first, and when the introduction of the separator caused a very general change of system, mistaken economy led to inadequate changes in the buildings, so that many creameries are now operated in quarters which are cramped, inconvenient, and hard to keep clean. Nevertheless, the average condition of Nebraska creameries as to buildings and equipment compares favorably with that in other States.

The West Point Creamery was the pioneer in this business in Nebraska, and probably the first to operate west of the Mississippi. It was established as early as 1878, before there was a creamery in the New England States. New York men were largely interested in the enterprise at its start, and as milch cows were then scarce in Cuming County, the company took up 800 acres of land and procured a stock of over 300 cows, so as to produce most of the milk needed. Guernsey and Jersey bulls, as well as some cows, were brought from the East, and the company graded up its herd. Holdings were increased, lands leased, and at one time the company owned 1,700 head of high grade dairy cattle. Feeding these cattle involved farming operations on a large scale, and as butter was the main article for sale, a large business was done in raising hogs on the skim milk. The silo system was adopted, and the farm has storage capacity for 800 tons of silage and 500 tons of sugar-beet pulp. As fast as offered this creamery took the product of neighboring farms on the cream-gathering plan and early adopted the advanced method of paying on the basis of tests by the oil-test churn. In 1891 the company was reorganized and has since done less in farming and live stock, but the creamery business has been extended, and besides butter, large sales of milk and cream are made in Omaha. The company has a large depot there and regards that city as the center of the market side of its operations. Enough cream is still bought in West Point and vicinity to make about 1,500 pounds of butter a day in the height of the season. The milk from 275 cows, on the home farm, mainly goes to the city market. One hundred heifers of high-grade Jersey and Guernsey blood are being reared to maintain and increase the herd. The entire establishment is under most capable and systematic management. A complete record is kept of the performance of every cow, and all the operations in the creamery are also the subject of current record. Yet it seems odd to find in such a large establishment that no separator is used, cream being raised by the old gravity method, with shotgun cans in cold pools, and fat tests of the skim milk and butter-milk are still unknown.

The daily milking of 200 to 300 cows is a serious business anywhere, and the labor question involved is often a difficult problem to manage. The West Point Creamery has adopted and successfully conducts a somewhat unusual system. From families of foreign extraction in the

neighborhood, 20 women are hired for an hour and a half at morning and the same time at evening, daily; these do the milking and do it exceptionally well and economically. They are paid 30 cents a day, and each one milks 14 cows in the allotted time; some of these women draw 300 pounds of milk in 90 minutes or less.

The Nebraska Creamery Association is located in Fremont, right in the city, and it operates there the largest plant of its kind in the State. This was established in 1881, being organized as a stock company, and it is still conducted as such. It has always been run on the cream-gathering plan, modified by the circumstances of location and the extent of the business. Cream alone is brought to the central factory. The supply is drawn from parts of 8 different counties, and comes by wagon over 20 routes, and also by rail from several separating stations maintained by the company at suitable points. All the gathered cream is sampled and subjected to the old style churn test, and upon these test results the payments to patrons are made. At the stations the milk is sampled and tested for fat by the Babcock method. At times in the past it was found that the cost of gathering cream by wagons was much too great, reaching 7 cents to the pound of butter, in some instances. Hence the plan has been adopted of paying cream gatherers according to quantity of butter made from the cream they deliver; 3 cents per pound of butter is paid in winter and $2\frac{1}{2}$ cents in summer. Various checks are used upon the gatherers to insure freshness and quality in the cream they bring. The factory managers greatly prefer cream from their own separating stations because in so much better condition, resulting in a higher grade of butter. The railroad freight on the cream from stations within 30 miles is 15 to 20 cents per can of 10 gallons, can returned free. With the exception of small local sales, this large establishment makes all the cream it receives into butter, and generally sells the entire product to dealers who receive the same at the railroad platform adjacent to factory. Buttermilk is sold to patrons at 25 cents a barrel, and to outsiders, who buy it quite largely at the factory, at the same price for a 10-gallon can. The largest business was done by this creamery in the year 1887, when as much as $2\frac{1}{2}$ tons of butter were made per day. Various causes have since decreased the product, which has been from 1,000 to 1,500 pounds daily during the past year. Patrons at the separating stations have lately been paid an average of 12 cents per pound of butter fat in the milk delivered by them; and those upon the gathering routes have been paid 10 and 11 cents per pound of butter oil, determined by the oil-test churn.

It is worthy of note that several attempts by farmers in the vicinity of Fremont to conduct cooperative creameries have failed. These have been small concerns and without experienced business management. The rivalry of the big factory, and the economy possible because of the extent of its operations, appear to have been too much for successful opposition. Yet this creamery has never paid large dividends to its

stockholders, and at times it has run at a loss. The capital stock was originally \$50,000, but it has been reduced one-half.

Among the creameries of Nebraska, a group known as the South Platte creameries is worthy of special note. These are located in the four adjoining counties of Butler, Polk, York, and Hamilton, the central factory and office being at Aurora, in the last county named.

The Waterloo Creamery Association is another large concern, owning 1,500 acres of land and keeping 400 cows in Douglas County. It is mainly engaged in the milk supply of Omaha, having its office and principal depot in that city.

In South Dakota, the creamery business may be fairly said to have been "booming" during the years 1895 and 1896. Fully 100 new creameries commenced business in the spring of 1896. Nearly all of these are separator factories, no other system being heard of now. A good many of these are cooperative creameries, and such have naturally made the best payments to patrons. The highest average payment for milk reported the past season was 73 cents per hundred pounds, by a cooperative concern, and from this the rates ranged down to 49 cents for a proprietary factory. The average for the State must have been about 62 cents per hundredweight of milk. This shows an excellent average quality of milk.

It is interesting to note that the greatest successes in these new creamery ventures have been in neighborhoods where crop failures have seemed disastrous. This is partly explained by the remark of one patron: "Yes, I like the creamery first rate. Last year I kept only 3 cows and this year have 24. I *had* to do *something*, and the cows were the only things that paid. But I had to be starved into feeding them and milking them."

A good many of the creameries a year or two old, some even less, have had to be enlarged and their general condition seems to be healthy. Some failures there must be, and a few cases are noted where crop failures were so complete as to force patrons to sell their cows.

North Dakota reports are few and unreliable. In this State a good ice supply can be relied upon and the cream-gathering system is therefore in more favor. The average quality of milk seems to be even better than in South Dakota, but the payments to patrons for milk and cream are at lower rates. All the natural conditions favor the rapid and successful extension of dairying under the creamery system in the southeastern portion of this State.

Nearly all the creameries in these three States are built of wood, with iron smokestacks, and, according to the best information obtainable, not one-third of them are insured. The most common causes for criticism are faulty management of the waste products, buttermilk and skim milk, and insufficient provision for drainage, which will surely result in serious trouble after a time. The general interior care is of about average grade, but in a good many places there is need of

constant repetition and enforcement of the fundamental creamery rules for order and cleanliness.

CHEESE FACTORIES.

Cheese making on the factory plan has not become established to any extent in the three States under consideration. North Dakota seems to have done more than the others in proportion to age and population, although the aggregate product of Nebraska is larger. It is claimed that during last year about 1,000,000 pounds of cheese were made in factories in the latter State and about half as much on farms. In North Dakota the estimate for the same year is 400,000 pounds for factory cheese; this is probably in excess of the fact. In Nebraska reports show about $9\frac{1}{2}$ pounds of cheese produced from 100 pounds of milk, and North Dakota reports show something over 10 pounds. In the former State one factory paid an average of 63 cents per hundredweight for milk; this was doing well. The factories in these States seem to run very short seasons, and their greatest difficulty is in curing. Good curing rooms are rare. In Nebraska, and perhaps in South Dakota, it will probably be found necessary to put the curing room partly under ground to secure even temperature, but it must be kept dry and well ventilated. Expensive buildings are needless. In some parts of the West there are cheese-curing rooms dug 4 or 5 feet into the ground, carefully drained, and the earth walls simply lined with matched boards; there is a building above to partly shade the place. Such rooms, properly managed, are found to answer their purpose well.

The progress made already shows that opportunities and conditions are good for successful cheese factories in Nebraska and the Dakotas, and their number can be largely increased to advantage if a home trade can be worked up for their products. This should not be difficult.

EXTENT AND VALUE OF DAIRY INTERESTS.

From all obtainable data, an estimate has been made of the principal items connected with the dairy industry in these States. The figures given in the following table can not be verified, but there are good reasons for considering them approximately correct:

Extent and value of dairy interests in Nebraska, South Dakota, and North Dakota.

State.	Milk cows owned.	Value of cows (estimated).	Milk produced—yearly quantity and value.				Creameries.	Cheese factories.
			Average yield per cow.	Total milk produced annually.	Value of milk per cwt.	Total value of milk produced annually.		
	<i>Number.</i>	<i>Dollars.</i>	<i>Lbs.</i>	<i>Cwt.</i>	<i>Cents.</i>	<i>Dollars.</i>	<i>No.</i>	<i>No.</i>
Nebraska.....	563,313	13,000,000	2,430	13,688,500	53	7,254,905	119	2
South Dakota.....	278,928	6,400,000	2,500	6,973,000	61	4,253,530	89	2
North Dakota.....	146,328	3,250,000	2,300	3,365,000	55	1,850,750	27	6

The most probable cause of error in this table is the low annual milk yield assigned to the cows in these States, but the rates given are sustained by reports of actual facts, which appear to be reliable. The figures exhibit the average milch cow of this region to be an animal of very doubtful profit, for in South Dakota, which makes the best showing, the gross income per cow, in milk, would be but \$15 a year.

GENERAL REMARKS.

An evil which exists in these States, and appears to be increasing, is the system of short-term tenantry on farms. The extension of dairying and progressive farming in any form is likely to be very slow while this system prevails. It is usual to find in almost every town and village in these States capitalists (or their agents) who own several farms and who rent them on shares. This would not be very objectionable if the farms were leased for terms of ten years or more. But the one-year term is very common, if not the rule, and this is detrimental alike to the interests of owner and tenant. It is incompatible with good farming, and sure to result in deterioration of the farms. Bankers, agents, and all concerned should encourage the division of lands into small farms and their settlement by owners, or leasing on long terms, if at all.

Bankers, merchants, and professional men do not seem to sufficiently realize how closely their interests are allied with the condition of farming in their region. They should encourage enterprise in farming in every possible way; aid and patronize educational organizations, institutions, and meetings—like farmers' institutes, conventions, and dairy schools—and generally assist in the application of intelligence and enterprise to the farm and dairy interests of their States.



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BULLETIN NO. 17.

(Dairy No. 8.)

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.

DAIRY SCHOOLS.

BY

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Under the direction of
Dr. D. E. SALMON,
Chief of the Bureau of Animal Industry.



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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., November 13, 1896.

SIR: I have the honor to transmit herewith the manuscript of an article on "Dairy Schools," prepared under the supervision of Henry E. Alvord, Chief of Dairy Division of this Bureau, and to recommend its early publication as a bulletin of this office. Dairy schools have been established in this country only a few years, but the good results of their work are already apparent. Many dairymen do not know of these schools or have only a vague idea of them, and it is the purpose of this bulletin to spread information on these points and to show some of the advantages of special training in dairy lines. An appendix to the bulletin contains statements of the facilities for instruction in dairying in the States and Territories.

Respectfully,

D. E. SALMON,
Chief of the Bureau of Animal Industry.

Hon. J. STERLING MORTON,
Secretary of Agriculture.



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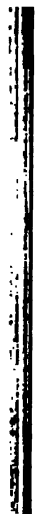
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DAIRY SCHOOLS.

DAIRY INSTRUCTION.

The fact that a young man has attended a dairy school and has successfully completed the course there offered, commends him to anyone looking for a person to fill a responsible position in a creamery or cheese factory or to take charge of a farm dairy. Scientific education in agricultural lines is no longer looked upon as impracticable and useless, and the one possessing it is not now necessarily considered a theorist; on the contrary, education is regarded with more and more favor, it is recognized that practice and science are closely connected, and yield the best results when they are made to depend upon each other; rules of thumb can not compete with applied science. So far as special training is concerned, dairying is not different from other lines of industry, and in these times of rapid scientific and technical advancement and severe competition in all trades and professions, it is found that the butter and cheese maker and the dairyman are as much in need of the best and latest information relating to their work as the horticulturist or mechanic or tradesman is in need of the latest knowledge in his line.

Modern advances in dairy knowledge have been rapid; the scientist and inventor have caused the apparatus and routine in use a quarter of a century ago to be almost entirely discarded and replaced by more profitable machinery and more accurate methods. Although inventions of improved dairy machinery and scientific investigations in the field of dairying are comparatively recent, important discoveries and corresponding changes in methods of work have already been made. It is probable that these improvements have not much more than begun, and the results that have been obtained and will be obtained are certain to have a marked effect on the production and care of all dairy products. It is well known that the methods of butter making practiced twenty years ago can no longer be followed with profit; with modern aids more butter can be made from a given amount of milk of a given quality than it was then possible to produce.

Another feature of dairying which has undergone great change in late years is the market value of dairy products. The prices of milk, butter, and cheese have recently been so low and the cost of production

has so nearly equaled the market values of the products most economically produced, that it has become absolutely necessary to turn everything in dairy operations to the greatest possible gain if one would succeed in profitably producing milk, butter, or cheese. Skill and keen judgment are constantly required by the successful dairyman; no simply imitative methods can be depended upon if the best results are expected.

The changing conditions of the dairy industry, viz, its rapid advances in means and methods of manufacture, larger production of goods not always the best, and severe competition, have seemed to make it necessary to provide some places for giving instruction in the most advanced dairy methods. Dairy schools have been established to meet this pressing need, and their establishment marks an important era in the history of agricultural education. Soon after the organization of agricultural colleges it was learned that they could not reach, through the long courses, the great majority of dairymen and butter and cheese makers who needed practical and theoretical instruction. Shorter courses were offered, with varying success, and it was finally decided to give instruction in dairying alone for a few weeks each winter. This departure has proved to be a boon to dairying. Dairy schools are now found in every State where dairying is a prominent industry, and other States are ready to give similar opportunities for dairy instruction as soon as it is needed. These schools are usually connected with State agricultural colleges which furnish instructors and equipment. In a few States splendid buildings have been erected for the single purpose of dairy teaching. In other States creameries or cheese factories or buildings containing both have been erected for the practical operations, and class-room work is conducted in the college buildings. Schools with the largest equipment are naturally located in the chief dairy States.

PURPOSE OF DAIRY SCHOOLS.

It is the purpose of dairy schools to teach young men or women, in a short time, as much as possible of the theory of the different lines of work connected with dairying; and these theories are illustrated, so far as practicable, in actual practice at the churn, cheese vat, or other apparatus. They aim to so equip one who has had some practical work that he will be able to take full charge of a plant and make the best possible product. And they attempt to teach one who has had little or no practical training the things that it took his father many years to learn. They aim to improve the quality of our dairy products and to reduce the cost of their production by teaching new and advanced principles, together with methods which have been proven to yield the best results. There is no reason why as good butter or cheese can not be produced in this country as is made in any part of the world, yet it is a painful fact that, while many of our manufactured products excel all of their kind made in other lands, our dairy products can not compete in foreign markets with the butter and cheese of several coun-

tries. Our successful competitors depend on their herds for their daily bread. They realize that it is to their interest to thoroughly understand every step in their work and have carefully organized systems of dairy instruction which have been conducted for years.

It is not the purpose of short dairy courses to displace longer courses in agriculture. Each has its own place in the field of agricultural instruction, and dairy schools occupy a place that had been practically vacant. The long course of agriculture which requires four years for completion is thorough and comprehensive, and if one desiring dairy training can take that it is undoubtedly the best thing to do. Four years is none too much time to devote to the study of dairying and closely allied subjects. If it is possible to spend only two years and few outside subjects are taken, a good training can be obtained in that time. By taking these longer courses one can obtain all the instruction given in the short course and a great deal more; in fact, he has an opportunity to learn much that is now known of dairying and at the same time gain a fair knowledge of agriculture, chemistry, bacteriology, and other subjects allied to dairying and of general importance and interest. But the full course in agriculture or a special course of one or two years requires time and money for preparation and completion, and it is, therefore, beyond the means of many to take either of them.

There is a large class of ambitious young men and women who can not afford a long course at college, and of others who are not interested in anything but dairying, strictly. With many the time is limited and they prefer to become as proficient as possible in one line, rather than attempt to get a few ideas in several different lines. It is for such as these, chiefly, that short dairy courses have been arranged, and it is endeavored to place them within the reach of all, as one of the first necessary steps toward the improvement of our dairy products is education of the *many* makers of butter and cheese. Each one must be properly trained, and schools adapted to but a few could not accomplish that end.

The dairy schools receive without special preparation any who are actually engaged in making butter or cheese, or who intend to make that their business. The work is so arranged that an intelligent person can get great help by devoting all his time for a few weeks to the study of dairy methods under the guidance of competent instructors. It must not be thought that all the complexities of dairying can be learned in a few weeks or months, but in this short period many useful ideas, advanced principles and methods can be obtained.

METHOD OF CONDUCTING DAIRY SCHOOLS.

As the most active season of dairying is in the spring, summer, and fall months, the period of work of the dairy schools has been placed in the winter, thus enabling many who are in charge of factories to finish the season's work, take the course, and open the factory the following

spring, while others whose factories run the whole year can be relieved of the work for a few weeks in winter more easily than any other time. The schools being established for those who can attend but a short period, the work is so planned that on each week day the student's time is fully occupied. Care is taken to have the scientific and practical instruction so closely related that one will help the other in the daily work. The student is not only told in lectures how to make good butter and cheese, but he is shown the complete process and performs the work himself until familiar with it. After he learns the principles of making a first-class product he is shown how to judge or score it, a blank like the following being used:

Blank used for judging butter at the Wisconsin Dairy School.

Report by Date,, 189 .

No. of sample.....						
<i>Scale of points.</i>						
Flavor	40					
Grain	30					
Color	15					
Salt	10					
Package	5					
Total	100					

This is an important exercise and a great help in detecting just where an error was made in the process of manufacture. It is also an aid to understand the expert criticisms of the product after it has reached market.

The subjects in which instruction is given depend largely on the condition of dairying in the State where a school is located. General lectures on dairying are given at all schools, and instruction in the use of the Babcock and lactometer tests and in butter making is always given. Cheese making is an important industry in only a few States, and the fullest instruction in that branch may be expected in those States where the most cheese is made. The pasteurization and sterilization of milk with different kinds of machines, and the preparation of milk for the retail city market, are taught in some States. A few schools have most excellent facilities for advanced work and original investigation in dairy lines, and students who are proficient in the elementary work are encouraged to take up something more advanced. The science of dairying offers a promising field for investigation and good reward for successful work. Many short-course students have become so interested in this that they have been led to take a full four years' course in agriculture after completing the short course, and have become leading authorities on agricultural matters in their communities. Sufficient practical engineering is given in some schools to enable one to do his own steam fitting, plumbing, belting, and simple repairing. Some bacteriology is taught and an effort made to impress the

fact that bacteria are the chief cause of good or harm in the dairy. Under the head of chemistry, is taught the composition of milk and its products and the relations of their several parts. In a few cases students have opportunity to perform some simple operations in milk analysis, thus making a better impression on their minds than can be done by lectures alone.

The class usually assembles at 8 o'clock in the morning to take one or more lectures, which are intended to cover much more ground than the practical work. Some of the subjects discussed and which were not mentioned above are breeds, breeding, feeding and animal nutrition, selecting and judging cattle, manures, farm buildings, market quotations and requirements, veterinary science, law, and creamery bookkeeping.

Special attention is given to the lectures directly bearing on the daily practical work. The importance of having the best milk is clearly shown. All the details of handling milk both before and after delivery to the factory are explained. These include milking, straining, aerating, cooling, care previous to delivery, and hauling to factory; also the receipt of milk at the factory, the examining, weighing, sampling, and conducting to milk vat. The lectures on testing milk briefly describe the simplest tests which have been used and fully explain the method devised by Dr. Babcock. The payment for milk according to its fat content is explained and illustrated. In the lectures on butter making, every step of the work from taking the milk from the vat to shipping butter to the market is fully described. The lectures on cheese making cover that subject from the receipt of the milk to the shipment of cheese. Instruction is usually given in cheddar-cheese making only, but in some schools the manufacture of several kinds of cheese is described. The advantages, disadvantages, and best methods of pasteurization and sterilization are explained in some courses of lectures. The proper method of constructing dairy buildings is discussed, special importance being given to the sanitary side, the disposal of skim milk and waste products, laying of drains, etc.

The part of the instruction upon which most dependence is placed is the practical work. It is by means of this that new ideas are most effectually fixed in the minds of students. This should never be considered as manual labor, as it is not that in any sense. When the classroom work is completed different sections of the class are assigned to various duties in connection with practical dairy work, such as receiving milk, tending to separators, churning, cheese making, and pasteurizing and testing milk, and the assignments of the different sections are changed regularly, so that each student has an opportunity to gain experience in each branch of the work. In some schools the class is divided into three sections, each section working in the butter room, cheese room, and laboratory by turns. These sections are again divided into smaller sections and assigned by the instructor to perform different

duties; for example, of those assigned to the butter room some take charge of the separators, others attend to the churning, while others print and pack butter. All the work is executed under the immediate supervision of a competent instructor and careful attention to details is required. When a student is assigned to any duty a report blank is given him similar to those here shown. It provides for reporting each step in the work, and thus teaches accuracy and observation.

Blank used for milk-testing report at the New York Dairy School.

Report by Date,, 189 .

No. of sample.	No. of bottle.	Lactometer reading.	Temperature.	Specific gravity at 60° F.	Per cent of fat.	Solids-not-fat.	Adulteration, kind and amount.

Blank used for separator report at the Iowa Dairy School.

Date, By

Temperature of milk when received.....	Speed of separator 5 minutes after starting.....
Temperature separated.....	Speed of separator 30 minutes after starting.....
Which separator used.....	Speed of separator 1 hour after starting.....
Started separator at.....	Pounds of milk run through per hour.....
Reached full speed at.....	Temperature of skim milk.....
Fat in skim milk 5 minutes after starting.....	Temperature of cream.....
Fat in skim milk 30 minutes after starting.....	Temperature of cream in vat.....
Fat in skim milk 1 hour after starting.....	Temperature of water surrounding vat.....
Solids-not-fat in skim milk 1 hour after starting.....	
Fat in cream 1 hour after starting.....	

Remarks:

Blank used for cheese-making report at the New York Dairy School.

Report by Date,, 189 .

Vat used.....	Time of first curdling.....
Condition of milk.....	Minutes taken.....
Weight of milk.....	Time cut.....
Rennet test for ripeness.....	Minutes taken.....
Temperature set.....	Time steam turned on.....
Amount of rennet used.....	Minutes taken.....
Rate of rennet per 1,000 pounds milk.....	Time steam turned off.....
Hot iron test when dipped.....	Minutes taken in raising to..... degrees.....
Hot iron test when ground.....	Time dipped.....
Weight of salt used.....	Minutes taken.....
Rate of salt per 1,000 pounds milk.....	Time ground.....
Per cent of fat in milk.....	Minutes taken.....
Per cent of fat in whey.....	Time salted.....
Weight of fat lost.....	Minutes taken.....
Kind of cheese.....	Time put to press.....
Number made.....	Whole time for setting.....
Weight of green cheese.....	Time dressed.....
Weight of milk for 1 pound green cheese.....	Time taken from press.....
Serial number.....	Length of time in press.....
Time set.....	

Remarks:

Farm dairying, or the making of dairy products on a small scale, is usually taught in the short course of agriculture with other subjects,

such as horticulture, general agriculture, and entomology. In most of the States where the factory industry is not extensive and the classes in dairying are not too large, the farm dairy instruction is given in connection with the creamery and cheese factory work. In this course it is endeavored to show how to make good butter in small amounts and with ordinary utensils, such as are found on the average dairy farm, as well as with the most approved aids. Lectures are usually given on breeding, feeding, and judging dairy cattle, management of the dairy, diseases of the dairy cow, the composition of milk, and the manufacture of dairy products. Practical work is included in separating cream by gravity and by hand separators, and making butter in small amounts and preparing it for the market. These courses have enabled many farmers to so improve their butter as to increase its price 2 or 3 cents a pound.

REQUIREMENTS FOR ADMISSION.

The entrance requirements to dairy schools are such as to debar no worthy person who really desires to attend. Any person of good character who wishes to study dairying and is capable of understanding the lectures and doing the practical work will be admitted to almost any school. In some cases there are age requirements, and in a few instances examinations are given or statements must be presented showing that the applicant has had a certain amount of experience in a cheese factory or creamery. These easy entrance requirements, however, should not encourage anyone who is not fitted for the work to attempt to take it. An applicant should be at least 16 years old, and it is well to have some knowledge of farm and dairy methods, although some of the best results have been shown by ambitious young men from the city who knew nothing of cattle or milk before taking the course. One should be possessed of a common school education, be able to read and write, and understand fractions, percentage, and decimals. Without such knowledge it is possible to make good butter or good cheese, but not possible to take charge of testing milk or apportioning dividends. Each student entering a dairy short course should have a strong desire to become expert in some part of the work, and this fact should be kept in mind throughout the course.

Women are usually admitted to the schools on the same conditions as men. They have always been interested in the farm dairy, and are now successfully taking charge of large dairy plants. It would seem a great mistake to exclude anyone engaged in dairying from attending a dairy school, which should be ready to aid as many as possible.

CERTIFICATES AND PRIZES.

Certificates are awarded by some schools to students successfully completing the course. These do not necessarily recommend the holder to fill any position in a creamery or cheese factory, but usually simply

state that he has creditably finished the prescribed work. Such a one is here shown:

Certificate awarded by the New Hampshire Dairy School.

This certifies that ———— has been a regularly enrolled member of the dairy school of this college during the session of 189—, has attended the lecture courses, has done the prescribed work with the separators and churns and in milk testing, and has been found proficient by his instructors in the exercises required.

Given at ———, ———, this ——— day of ———, 189—.

—————,
Professor of Agriculture.

—————,
Creamery Instructor.

[SEAL.]

Countersigned:

—————,
President of the College.

A student may finish the work of the dairy school and be able to make the best butter or cheese under similar conditions as were there afforded him, but he can not always do as well under the adverse circumstances sometimes met by practical butter and cheese makers. To successfully cope with all conditions long experience is required. Sometimes the certificate is not given until the student has had one or two seasons of practical work, concerning which a blank statement similar to the following is filled out and sent in monthly:

Blank used for report in creamery work by the Wisconsin Dairy School.

Report by ———— for the month of ———, 189—.

Name of creamery in which you work.....
Location of creamery: P. O....., County....., State.....
Nearest railway station.....
What position do you hold, first man or helper?.....
Is creamery cooperative or private?..... Number of patrons.....
Number of cows..... Pounds of milk received daily.....
Distance to next creamery or cheese factory.....
Distance from creamery to farthest patron.....
Are dividends made according to the per cent of fat in the milk?.....
Do you use composite test?..... How often is each patron's milk tested?.....
What is the highest per cent of fat found in any patron's milk during this month?..
What is the lowest per cent of fat found in any patron's milk during this month?..
Average fat in mixed milk from all patrons.....
What separator is used?..... About what proportion of cream is taken?.....
At what temperature is milk separated?.....
How much milk is separated per hour?.....
What per cent of fat is left in skim milk?.....
Have you been troubled by separator churning the cream?.....
How is cream ripened?..... How long is cream held before churning?.....
At what temperature is cream kept?.....
At what temperature is it churned?.....
How long on the average is cream churned?.....
Is butter worked once or twice?..... How much salt is used?.....
What kind of salt do you use?..... Are you bothered with mottled butter?....

How much fat is left in buttermilk?.....
 What per cent lactic acid is in cream when churned (Mann's acid test, or Farrington's tablet)?.....
 How much butter, packed ready for market, is made from one pound of fat, as shown by test?.....
 How much butter has been sold during the month?.....
 State highest, lowest, and average prices obtained.....
 How much is charged per pound for making?.....
 Do patrons take back skim milk?.....
 How is skim milk divided among patrons?.....
 Remarks:

In addition to this he is visited at his factory by his former dairy instructors, whose reports must show that the factory is well conducted. A certificate based on these conditions is a valuable thing, and of course a great aid in securing a position.

The practice of giving prizes to the best students has been adopted in some schools. The award of these prizes is based entirely on the work done at the school. They furnish an incentive to put forth one's best efforts and they make the school work more interesting by causing friendly competition. It has been the custom in some schools of England to give the best students an extended and advanced course without cost.

COST OF DAIRY COURSE.

In a few cases tuition is required of all students admitted to the dairy course, but this is never a large amount, rarely exceeding \$15. A deposit of from \$2 to \$5 is usually made to cover any loss by breakage, and the amount of this remaining unused is returned to the student at the end of the term. Each member of the course is given a full set of glassware for testing milk, and if he meets with no accident and returns a complete set he receives back the entire amount of his deposit. If a few pieces are broken, enough is deducted from the deposit to replace them and the remainder is returned. Board and room can be found at prices varying from \$2.50 to \$5 per week and laundry work costs about 50 cents more each week. Most schools require students to wear white suits when at work in the dairy building. Those made of white duck, similar to the ones worn by painters, are very satisfactory and can usually be obtained for \$1 a suit. Each student should have at least two suits. The incidental expenses depend largely on the individual; they can be kept quite low if necessary.

It is thus seen that the total cost of attending a dairy school is very reasonable—exclusive of the railroad fare in going and returning—it may even be as low as \$25. With few exceptions \$50 will cover the entire outlay. Some energetic young men have been able to make a large part of their expenses while attending such a school by working in the barns and on the farms connected with the college, but it is not safe to depend on this unless assured beforehand that work can be obtained, as there are seldom as many positions as persons seeking them.

In the brief statements of the schools, in the appendix, the estimated amount of the required expense in each case is given. Laundry and incidentals are not included. Each student should have a few blank books for taking notes in the lectures and laboratories. The price of board and room varies with the location and the accommodations offered; the lowest price is usually stated.

EQUIPMENT.

A few schools are equipped with buildings which have been erected at the expense of the States for the purpose of dairy instruction only. These buildings are as complete and perfect in construction and as fine in appearance as other college buildings and lack nothing in arrange-



FIG. 1.—Receiving and sampling milk, college creamery, Iowa.

ment or equipment which would aid in the purpose for which they are intended (Pl. I). They contain both lecture rooms and work rooms, also laboratories, reading rooms, libraries, bath rooms, and dressing rooms. Each building is so arranged that all the work connected with butter making is done in a part by itself, and practical cheese making is carried on in another part. The work rooms are arranged as nearly as possible like a modern creamery or cheese factory. The receiving room (fig. 1) contains a receiving can, scales, various arrangements for taking samples of milk, and milk vats or conductors leading to vats in



FIG. 1.—DAIRY HALL, NEW YORK.



FIG. 2.—DAIRY HALL, WISCONSIN.





FIG. 1.—CHURNING ROOM, DAIRY SHORT COURSE, WISCONSIN.

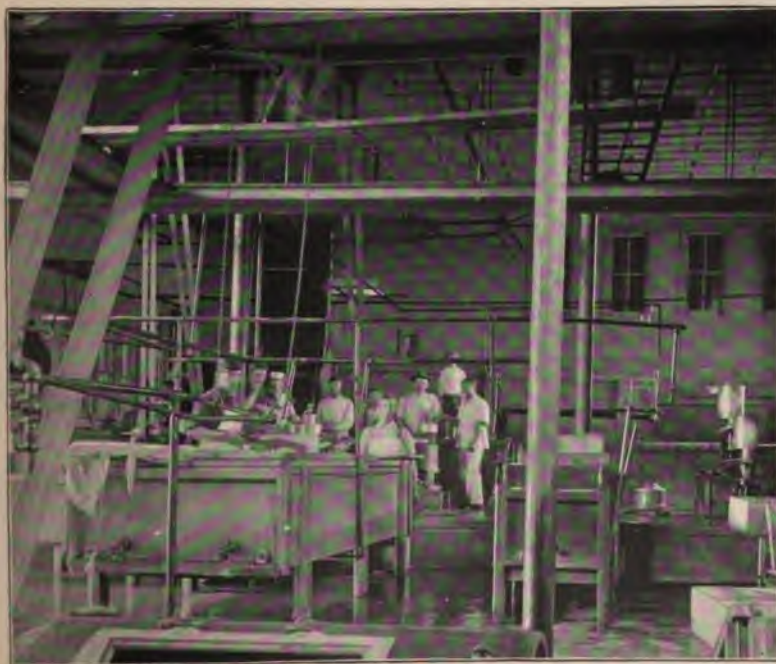


FIG. 2.—OPERATING SEPARATORS, CREAMERY COURSE, IOWA.





FIG. 1.—PASTEURIZING MILK, ILLINOIS.



FIG. 2.—CHEESE ROOM, MINNESOTA.



Industrial structure



FIG. 1.—MILK LABORATORY, MINNESOTA.



FIG. 2.—LIVE STOCK LECTURE ROOM. MINNESOTA

another room. The butter room (Pl. II) is fitted with all the apparatus necessary to make large or small amounts of butter—separators, cream ripening vats, churns, and butter workers, and usually different styles of each kind of machinery are in use, so that several squads can be working at the same time on the same kind of work, but with varied appliances. Each student changes from one kind of apparatus to another until he becomes familiar with all. Manufacturers frequently loan dairy machinery to the schools, thus getting a good opportunity to make their implements known, while the equipment of the school is increased and improved. In the cheese room (Pl. III, fig. 2) are found small cheese vats and all the accessories necessary in cheese making. In connection with this room is the curing room, where it is customary to keep careful record of the heat and moisture conditions throughout the term.

The laboratory (Pl. IV, fig. 1) resembles in many respects a chemical laboratory. Long benches are provided with drawers and closets, sinks, hot and cold water, and gas. Numerous testing machines run by direct steam jets, belt, and hand power are placed in the laboratory. Jars of sulphuric acid with rapid measuring arrangements for use in filling test bottles and apparatus for the acid tests and other experimental and chemical work have their place in this room. Each student keeps the glassware necessary for testing milk, cream, and skim milk in his own locker. Usually the lactometer and acid tests are used, and some of the earlier known rapid fat tests are sometimes shown. The reading room and library contain numerous dairy papers and books, herd books, etc. When special rooms are provided for instruction in farm dairying they are equipped with hand churns and separators, the conditions being made as near like those of a model farm dairy as possible. A special room is used for the engine and boiler, and instruction may here be given in firing, steam fitting, plumbing, and the care of the engine. (Pl. II, fig. 1.)

The lecture room is fitted with seats, having a wide folding arm rest suitable for holding a notebook. Blackboards and charts are on the wall for use in illustrating the lectures. A live stock lecture room (Pl. IV, fig. 2) is now in use in a few schools. It contains a large platform where animals can be brought in full view of the class and their peculiar and prominent points of excellence or failure discussed.

Schools not equipped with buildings as above described usually operate a creamery and perform all practical work in a building by itself, and conduct class-room work in other buildings. The fact that they have no costly structure is not evidence that they can not give good dairy instruction. (Pl. III, fig. 1.) (See fig. 2. text.)

Most dairy schools control herds of cows which furnish a part of their milk supply. In some cases these are pure bred, and the herd may contain animals of several different breeds; in other cases grade herds are kept with the intention of illustrating how a good herd can

be built up from native stock at little or no more expense than is required to keep an ordinary herd with no improvement from year to year. The advantage of having cows of the best types, and medium good and poor animals, is evident.



FIG. 2.—College creamery at Fargo, N. Dak.

Other facilities which aid in giving dairy instruction consist of college and experiment station libraries and farms well equipped with buildings and machinery, silos, feed cutters, grinders, and, frequently, electric power. The associations formed at dairy schools may become of great value long after the course is ended.

ADVANTAGES OF A DAIRY COURSE.

The benefits of a dairy course are so many that only a part of them can be mentioned here. The chief advantage of any kind of education is that it trains one to think. Dairymen should know *why* as well as *how*, and the one who understands the reasons for each of the steps in making dairy products is the one who most successfully meets unexpected and unfavorable conditions when they occur. Good operators who can think and who possess some original resources are wanted by creamery and cheese-factory managers. The latter are not slow to learn that an employee, understanding practical dairy work and capable of sound reasoning, is worth much more than the one who acts mechanically. If the skim milk or whey can be made to test one-tenth per cent less in butter fat, they want the man who can do it. There is a demand for good dairymen, and it is doubtful if many up-to-date butter makers or cheese makers can be found in the army of "educated unemployed;" such men are needed in too many places. The best students from the

dairy schools are usually successful in securing first-class positions; in fact, the schools are sometimes unable to fill all the positions referred to them because of the lack of candidates.

Another benefit of special dairy training is, it makes one more independent. It frequently happens that the profits from a dairy concern can be much increased by changing the kind of product. If the butter market is depressed, it may be well to manufacture cheese for a time, or if the milk market is flooded, it will very likely be advantageous to the shipper or the dealer to make butter or cheese for a few days, until normal conditions of the market are resumed. This matter of being able to change at the right time may save many dollars' worth of milk which would otherwise be a total loss.

A great advantage of dairy schools is that they teach the same methods to all students, and in this way have much influence in making dairy products more uniform. Butter and cheese have been justly criticised for lack of this quality, but greater uniformity is already noticed as the result of dairy school training. Though several different lots of butter, alike except in minor particulars, may be equally good, they do not sell as well on the market as they would if more alike. When the makers in any section have been trained to ripen their cream in the same way, churn it at the same stage, use salt and color in the same degree, and pack the product in the same way, material benefits will accrue to all the creameries in that community.

From a financial standpoint a short dairy course may be regarded by an ambitious person who is much interested in dairying as a good investment. Many earnest men and women, limited in both time and money, have been able to help themselves very considerably by making the most of a few weeks at a dairy school. It must be remembered that tact and skill and keen interest in the work are necessary; without these the manager of a new and promising dairy enterprise may ruin it, but with them an ordinary place may be made to prosper and be a source of great profit to the community. Many run-down and struggling creameries are scattered through the country; often their unprosperous condition is due to a small supply of milk—this is beyond the control of the operator. But the trouble is sometimes in the factory itself, and in such a case an intelligent, energetic operator is usually the one thing needed.

A few cases may be cited showing how dairy schools have benefited individuals. A young man who had spent all his life at ordinary farm work and had very little knowledge of dairy methods took a ten weeks' creameryman's course and at its close obtained a position in a creamery paying \$50 a month for ten months in the year. Before taking the course he had been getting \$25 about eight months each year. Fifty dollars covered his entire expense at the school and by the outlay of this amount he more than doubled his income. The next winter he returned to the dairy school, heard the lectures a second

time, repeated a part of the work, and took some advanced study. He then secured a position which paid him \$55 per month with house rent free. The creamery of which this young man has charge has a neat, tidy appearance. He is agreeable to patrons and has the reputation of being the best creameryman in the community.

If one has had no practical experience in factory work he should endeavor to get at least one season's work as helper to a first-class maker. A man about 30 years of age had spent his life at general farm work. He decided to learn butter making and took a short dairy course, at the completion of which he became helper in a creamery at \$27 a month. The next year he was butter maker in another creamery at a salary of \$50 per month, and the next year, with one helper, he took charge of a large plant at a salary of \$60 per month and free house rent. The beginning of this improvement was a determination to excel in dairy work, and the first act was to attend a short dairy course which cost, in all, about \$50.

A young man who had just finished school attended a three months' dairy course at a total cost of nearly \$75. The next summer he took full charge of a creamery receiving 12,000 pounds of milk a day, and besides making the butter kept the books and apportioned payments on the basis of fat delivered. His butter was awarded both first and second premiums in a close contest at the county fair. He was paid \$65 a month. The next year he took full charge of a large creamery producing almost a ton of butter a day and had three assistants,—salary \$80 per month.

Similar examples could be given of cheese makers receiving much help by a dairy school training and the marked success of young women could also be cited. At a recent Western State fair more than half the premiums on dairy products were taken by students holding dairy school certificates. These illustrations are given to show that a short scientific training in dairying can be made good use of by a practical person who wishes to learn more of creamery or cheese-factory work.

Special dairy training can be a means of just as great profit to the dairy farmer as to the factory operator. The butter produced on farms is far from perfect. As a rule, it sells for several cents less than the "best creamery," although some farmers receive the highest market price for their product. It is not an uncommon occurrence for two farmers living close together, having the same kind of stock and the same advantages for dairying, to differ 50 per cent in the profits from their herds. Lack of uniformity is a chief criticism of farm dairy butter. This is mainly due to different methods in the care of milk and cream and in making the butter, and defects resulting from the incompetency of the maker. The dairy school offers to the busy farmer or any member of his family a quick and cheap way of learning the best methods. The value of farm dairy butter should be materially increased; this can be easily done, and would mean many thousands of

additional dollars to farmers. Farm dairy butter is often excellent in all points but one or two, which could be easily corrected. For example, it may not be well packed, though all right in other particulars; in such a case the use of a better package may raise the price a few cents per pound. Neat packages of well-made butter have been the means of lifting many mortgages.

Dairying has recently come to be regarded as the most profitable branch of agriculture in many localities where grain raising or general farming had been the leading occupation and farmers have been compelled to give their chief attention to their herds. Those who have not been in the business long, or have never put their best effort into it, little appreciate the great losses due to poor methods in feeding, selecting, and caring for stock and preparing the product for market. It has been shown repeatedly that one cow may easily produce twice the butter of another, making her profit more than double the profit from the poor cow. The lectures and practical work on selecting, judging, and managing stock give valuable instruction on these matters. It is claimed that the fat which remains in the skim milk and buttermilk on farms would increase the yield of farm dairy butter 25 per cent if it could be saved. Nearly all of this can be saved by the careful practice of modern methods.

ADVANTAGES OF DAIRY SCHOOLS TO THE PUBLIC.

Dairy schools are a benefit to the public as well as to the few individuals who attend them for instruction. In countries where they have been in operation for many years this is very evident, and in parts of this country the benefits may already be seen. Each school becomes a center for advanced dairy thought and each successive year, as class after class goes out, its influence is widened. Every student carries new ideas to his home, and though some may make little use of the training others will make much of it, both in their own work and in helping their neighbors. The creamery or cheese-factory operator occupies a peculiar place in the community; he is in a position to do much more than simply receive milk from the patrons and manufacture the product. If he understands the care and feeding of cows, the compounding of rations, value of manures, and, especially, the proper care of milk before its delivery at the factory, his advice on these things is of great value to the farmers whom he meets daily. The more the influence of these schools can be spread the greater will be their good to the public. Besides the community in which they are located, they benefit distant consuming communities by improving and cheapening dairy products.

If the money expended in the support of dairy schools is well used, a small amount of it is capable of doing great good. Many schemes have been proposed for aiding schools in the instruction of dairymen. In England traveling dairy schools have been tried with some success.

Dairymaids are sent out to remain on a single farm several days, teaching the best methods of conducting the dairy with whatever appliances may be at hand. With some persons sufficient interest is aroused to lead them to take a short course at a dairy school. This system of instruction could be followed with profit in parts of this country, especially in the outlying districts. If means were available, capable instructors might be advantageously employed for the entire year, spending the winter at dairy schools and the remaining months in the field. Valuable service for the State could be rendered by visiting farms and factories and showing in each place how the best product can be made under the conditions furnished. It is an excellent plan for dairy school instructors to visit their students after the completion of the course, when they have taken up practical work, to aid them in putting into practice the ideas gained at the school and to see if conditions exist which permit successful work.

The importance of instruction in farm dairying is very great. About 85 per cent of the butter produced in this country is made on farms, and as the quality of our dairy products as a whole can not be much improved until this large proportion shows improvement, the need is very evident of offering every inducement to learn to those who make butter in small amounts on the home farm. Several agencies have been used to supplement the efforts of the dairy schools in this line. Dairy conferences have been held in this country and good results thus accomplished. Courses of reading similar to the Chautauqua courses have been started; these might be directed from the dairy schools. Systematic instruction can also be given by correspondence.

APPENDIX.

Brief statements follow, showing the facilities for instruction in dairying now offered in the several States. Some schools receive generous support from the States in which they are located, and have everything necessary to enable them to do much good work. In other States the equipment is not on an elaborate scale; in a few there are no dairy schools, as there seems to be no demand for them. When the need for widespread education in dairy lines is better understood and the good results which accrue from such education are better appreciated, even more facilities for instruction will be offered than is the case to-day.

In the statements following, the names and locations of the different schools are given, together with the officers in charge and the proper officials to address for further information. The different courses of study which are offered are briefly described, the approximate cost of these courses stated, and certain features of the equipment referred to. In States where a large number of people are interested in dairying the classes at the dairy schools are usually large, and there is a correspondingly large force of instructors; some schools have been obliged to refuse admission to applicants on account of lack of room.

When one has concluded to attend a dairy school it is not always an easy matter to decide where to go. The school in his own State would be the natural place to choose, as it probably makes a specialty of the kind of dairying most practiced in that State. Each school naturally has the interests of its own State uppermost; for example, if cheese making is prominent in a certain State, that branch of the industry is likely to receive special attention at the dairy school of that State. If it is decided to attend a school in another State, the list following may be consulted, and when a few are found that seem to meet the requirements, their circulars should be obtained for further information:

ALABAMA.

Agricultural and Mechanical College of Alabama, Auburn.

[William Leroy Brown, M. A., LL. D., president; J. F. Duggar, M. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. J. F. Duggar, Auburn, Ala.

A regular short dairy course is not offered. A person desiring instruction in farm dairy work can spend the fall term of three months at the college and take dairying and allied subjects.

Cost: Fees, \$6; board and room, per week, \$2.50. (No uniform required.)

Equipment: A creamery, hand separator, and outfit for making butter in small quantities.

Other facilities: Experiment station and neighboring dairy herds.

Tuskegee Normal and Industrial Institute (incorporated), Tuskegee.

[Booker T. Washington, principal; J. H. Washington, superintendent of industries.]

For full information concerning dairy instruction address Prof. J. W. Hoffman, Tuskegee, Ala.

This institution is established for the education of colored young men and women. A course of eight months is offered in farm dairying, beginning early in September. Instruction is given by lectures and practical work. The lectures treat of milk, butter making, dairy chemistry and bacteriology, and dairy cattle.

Cost: Tuition (for dairy course), free; board and room, per week, \$2.25.

Equipment: A dairy building, well equipped for practical farm dairy work, testing of milk, butter making, etc.

Other facilities: Herd of pure bred and grade Jersey cattle.

ARIZONA.

University of Arizona, Tucson.

[Howard Billman, M. A., president; William Stowe Devol, B. Agr., professor of agriculture.]

For information concerning dairy instruction, address Prof. William S. Devol, Tucson, Ariz.

No regular short dairy course is offered; some dairy instruction is given, however, in the regular agricultural course. A person can attend for a brief period and receive instruction in dairying any time during the session of the university by making special arrangements with the professor of agriculture.

Cost: Tuition, free; board and room per week, \$4.

Equipment: Facilities for making butter and cheese.

ARKANSAS.

Arkansas Industrial University, Fayetteville.

[J. L. Buchanan, M. A., LL. D., president; R. L. Bennett, M. S., superintendent of agriculture.]

For full particulars concerning dairy instruction, address Prof. R. L. Bennett, Fayetteville, Ark.

A regular short dairy course is not offered, but instruction in dairying may be taken for a brief period in the winter term by making special arrangements with the professor of agriculture.

Cost: Tuition, free; board and room per week, \$3.

Equipment: All necessary appliances for conducting a modern dairy.

CALIFORNIA.

College of Agriculture and University of California, Berkeley.

[M. Kellogg, LL. D., president; E. W. Hilgard, Ph. D., LL. D., professor of agriculture.]

For full particulars concerning dairy instruction, address Prof. E. J. Wickson, Berkeley, Cal.

A special dairy course is not offered. A course of three lectures per week, beginning the middle of August and continuing six months, treats of stock breeding and dairy husbandry. This is given in connection with a lecture and laboratory course in dairy feeding. A laboratory course in the chemistry of milk and dairy products is also given. Special students who are qualified to carry out the work are taken for any period.

Cost: Laboratory fee per annum, \$10; board and room per month, \$20.

Equipment: Laboratory fully equipped for analyses of dairy products and feeding materials and with apparatus for milk testing. Growth of forage plants adapted to arid conditions.

COLORADO.

The State Agricultural College of Colorado, Fort Collins.

[Alton Ellis, M. A., Ph. D., LL. D., president; W. W. Cooke, B. S., M. A., professor of agriculture.]

For full particulars concerning dairy instruction, address Prof. W. W. Cooke, Fort Collins, Colo.

Instruction in butter making in small amounts is given in the short course of agriculture. Any person can receive instruction in milk testing at any time.

Cost: Tuition, free; board and room per week, \$3.

Equipment: Deep-setting apparatus, hand separator, and appliances for making butter in small lots. Efforts are being made to have a building erected suitable for giving instruction in creamery work.

Other facilities: A herd of cows supplies part of the milk used.

CONNECTICUT.

Storrs Agricultural College, Storrs.

[B. F. Koona, Ph. D., president; C. S. Phelps, B. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. C. S. Phelps, Storrs, Conn.

A short dairy course is not offered, but special students are admitted during the winter term of twelve weeks, and can put all their time on dairying and allied subjects if they so elect. Twenty lectures are given on dairy farming, the composition and testing of milk, manufacture of butter and cheese, and the preparation of milk and cream for market. The practical work consists of testing milk, separating milk by gravity and centrifugal methods, and butter making.

Cost: Tuition, free; board and room per week, \$3.

Equipment: One thousand five hundred dollars have recently been appropriated for new dairy machinery, and complete modern apparatus for giving instruction as outlined will be purchased. A complete dairy building is in process of construction, the creamery wing of which will be ready for use in January, 1897.

Other facilities: One thousand eight hundred dollars have been appropriated for the purchase of thoroughbred stock.

DELAWARE.

Delaware College, Newark.

[George A. Harter, M. A., Ph. D., president; W. H. Bishop, B. S., professor of agriculture.]

For information concerning dairy instruction, address Prof. W. H. Bishop, Newark, Del.

No regular short course in practical dairying is offered. Some dairy instruction is given by lectures in the agricultural course, and any person so desiring can take this work with other agricultural subjects in the short winter course.

Laboratory instruction in the use of the Babcock tester is also given.

Cost: Tuition, free; board and room per week, \$3.50.

Equipment: Babcock tester.

FLORIDA.

In Florida no instruction in dairying is offered at the State Agricultural College, located at Lake City.

GEORGIA.

Georgia State College of Agriculture and Mechanic Arts, Athens.

[H. C. White, Ph. D., president; J. B. Hunnicutt, B. A., professor of agriculture; H. J. Wing, instructor in dairying.]

For full particulars concerning dairy instruction, address H. J. Wing, Athens, Ga.

A regular short dairy course of two to three weeks in March is offered, and students desiring special instruction in milk testing or butter or cheese making are admitted at any time.

Cost: Tuition, free; board and room per week, \$2.50.

Equipment: A dairy building is fitted with the necessary apparatus for the work outlined.

IDAHO.

College of Agriculture of the University of Idaho, Moscow.

[F. B. Gault, M. S., president; C. P. Fox, M. Agr., professor of agriculture.]

For information concerning dairy instruction, address Prof. C. P. Fox, Moscow, Idaho.

Dairy course: A six weeks' course in farm dairy work commences early in November.

Cost: Tuition, free; board and room per week, \$3.50.

Equipment: Power and apparatus necessary for making butter and testing milk.

INDIANA.

School of Agriculture, Horticulture, and Veterinary Science of Purdue University, Lafayette.

[James H. Smart, M. A., LL. D., president; William C. Latta, M. S., director of the school of agriculture; C. S. Plumb, B. S., professor of animal industry and dairying.]

For full information concerning dairy instruction, address Prof. W. C. Latta, Lafayette, Ind.

Dairy course: An eleven weeks' course in farm dairying commences early in January. It is given in connection with other lines of agricultural instruction. The daily work consists of lectures on dairy subjects followed by practice in the dairy.

Students entering this course must be at least 16 years of age.

Cost: Students from Indiana, tuition, free; students from other States, tuition, \$10; deposit for breakage (returnable), \$2; incidental fee,* \$10; board and room, per week, \$2.50.

Equipment: A dairy building of five rooms is furnished with a complete outfit for making butter and cheese and for testing milk.

ILLINOIS.

College of Agriculture of the University of Illinois, Urbana.

[Andrew S. Draper, LL. D., president; Eugene Davenport, M. Agr., professor of animal husbandry and dean; W. J. Fraser, instructor in dairying.]

For full information concerning dairy instruction, address Prof. Eugene Davenport, Urbana, Ill.

Dairy course: The department of dairying has recently been established. A short course in farm dairying will be offered commencing early in January. Instruction will be given in testing and pasteurizing milk and cream, and making butter in small amounts.

* Two scholarships are offered each county agricultural society, farmers' institute, F. M. B. A., grange, etc., and the persons to whom these are granted are exempt from the incidental fee of \$10.

Cost: Tuition, free; board and room per week, \$3.

Equipment: The dairy building contains a small engine and boiler, pasteurizer and apparatus for making butter in small churnings, and arrangements for handling milk for city trade.

IOWA.

Iowa State College of Agriculture and Mechanic Arts, Ames.

[W. M. Beardshear, M. A., LL. D., president; James Wilson, professor of agriculture; G. L. McKay, instructor in dairying.]

For information concerning dairy instruction, address Prof. James Wilson, Ames, Iowa.

Courses: (a) An eight weeks' winter school in dairying commences early in January. It is planned for those who wish to make a specialty of dairying, and is mostly attended by men who have had practical experience in dairy work. Six half days per week are spent in practical work in the butter and cheese departments; class-room instruction is given by daily lectures on dairy operations, chemistry, bacteriology, and bookkeeping.

(b) and (c) Two summer schools of dairying begin, respectively, in February and July, and continue sixteen weeks. Instruction covers the same ground that is gone over in the winter course, but as the term is longer the different parts of the work can be taken up in greater detail; some experimental work is conducted.

(d) A one year's course is offered, and students successfully completing it are given certificates.

Cost: Tuition, free; board and room per week, \$3.50; two white suits, \$2.

Buildings: The dairy instruction is given in a building fitted as a large creamery, which is operated throughout the year. A cheese room, laboratory, class room, dressing room, and dwelling apartments are in the same building.

Equipment: The building is fitted with the necessary apparatus for making butter and cheese in large or small amounts and for testing milk.

Other facilities: A herd of cows representing six different breeds of cattle is kept on the farm and stabled in a building fitted with the latest improvements for dairy barns.

KANSAS.

Kansas State Agricultural College, Manhattan.

[George T. Fairchild, LL. D., president; C. C. Georgeson, M. S., professor of agriculture.]

For information concerning dairy instruction, address President George T. Fairchild, Manhattan, Kans.

No regular short course in dairying is offered. Instruction in the theory and practice of making butter in small amounts is given for ten weeks each spring term to the young women in the second year of the regular agricultural course.

Equipment: Deep and shallow setting apparatus for raising cream and appliances for making butter in small amounts.

KENTUCKY.

Agricultural and Mechanical College of Kentucky, Lexington.

[J. K. Patterson, Ph. D., president; C. W. Mathews, B. S., professor of agriculture; M. A. Scovell M. S., lecturer on dairying.]

For full information concerning dairy instruction, address Prof. C. W. Mathews, Lexington, Ky.

Dairy course: Instruction in farm dairying is given in connection with the regular eight weeks' short course in agriculture, beginning early in January. The field of

dairying is covered briefly by lectures; the practical work consists of fifteen 2-hour hour exercises in testing milk and making butter and cheese.

Cost: Tuition, residents of Kentucky, free; room and board per week, \$3.

Equipment: A dairy house has recently been erected and fully equipped for experimental work in handling milk and making butter and cheese.

Other facilities: A herd of cows on the college farm.

LOUISIANA.

In Louisiana no instruction in dairying is offered at the State Agricultural College, located at Baton Rouge.

MAINE.

Maine State College, Orono.

[Abram W. Harris, M. A., D. Sc., president; Charles D. Woods, B. S., professor of agriculture.]

For full information concerning dairy instruction address Prof Charles D. Woods, Orono, Me.

Dairy course: A six weeks' course in dairying is offered, commencing in January. It is designed for those who wish to become expert butter or cheese makers. If it is pursued two terms, and two seasons' satisfactory work is performed in a butter or cheese factory, the student will be granted a certificate of proficiency. Practical work is conducted each afternoon; in the mornings lectures are given on dairy cattle, dairy products and operations, care of boilers, diseases of cattle, and business law.

Cost: Tuition, free; board and room per week, \$3.50; two white suits, \$2.

Equipment: A building especially constructed for instruction in dairying is fitted with modern dairy appliances for testing milk and making butter and cheese.

MARYLAND.

Maryland Agricultural College, College Park.

[R. W. Sylvester, president; W. T. L. Taliaferro, professor of agriculture.]

For information concerning dairy instruction, address Prof. H. J. Patterson, College Park, Md.

No regular short dairy course is offered. Instruction in dairying is given to the agricultural students and twelve weeks of work in general dairy lines is offered to others each winter.

Cost: Tuition, \$5; board and room per week, \$5.

Equipment: A newly equipped dairy building.

MASSACHUSETTS.

Massachusetts Agricultural College, Amherst.

[Henry H. Goodell, LL. D., president; William P. Brooks, B. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. William P. Brooks, Amherst, Mass.

Dairy course: (a) An eleven weeks' course in creamery work commences early in January. Lectures are given on the principles of dairy farming, breeding and management of cattle, cattle diseases, stable construction, bookkeeping, composition of milk, pasteurization, milk testing, and butter making. Practical creamery work is conducted.

Applicants for this course must be 16 years of age or over.

Cost: Tuition to citizens of the State, free; laboratory fees, cost of materials; board and room per week, \$3.75; two white suits, \$2.

(b) A course in farm dairying is conducted at the same time in connection with the short winter course in agriculture.

Equipment: A wing of the barn, containing several rooms, has been fitted with modern machinery for practical and educational work in dairying as above outlined. Power is furnished by an electric motor.

Other facilities: A herd of selected grade cows is being bred with especial attention to their dairy qualifications; museum of illustrative material; agricultural library.

MICHIGAN.

Michigan Agricultural College, Agricultural College.

[J. L. Snyder, Ph. D., president; Clinton D. Smith, M. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. C. D. Smith, Agricultural College, Mich.

Dairy course: A six weeks' course in farm dairying is offered. The course begins early in January. Instruction is given by lectures and practical work, special attention being given to chemistry of milk, butter making, and stock judging and feeding. Practical butter making is conducted six half days each week and work at the barn mornings and afternoons.

Equipment: The basement of the experiment station building is fitted up for butter making in small amounts. Studies in bacteriology and chemistry are conducted in fully equipped laboratories.

Other facilities: A herd of cows representing eight different breeds is on the college farm; various forms of silos, stalls and fixtures are in operation.

MINNESOTA.

College of Agriculture of the University of Minnesota, Minneapolis.

[Cyrus Northrup, LL. D., president; William M. Liggett, dean. School of Agriculture, St. Anthony Park. Henry Webb Brewster, Ph. D., principal; T. L. Haecker, professor of dairy husbandry, in charge of dairy school.]

For full information concerning dairy instruction, address Prof. T. L. Haecker, St. Anthony Park, Minn.

Dairy courses: (a) A four weeks' course, commencing early in January, is designed for butter and cheese makers who have had at least one season's experience in factory work. The course consists of sixty lectures on the various branches of dairying and closely allied subjects. The practical work consists of the making of butter in small and large amounts, manufacture of cheese, including the Swiss, brick, Edam, and Gouda varieties, methods of testing milk, scoring butter and cheese, and practical engineering. Each morning is given to lectures and all afternoons to practical work.

Certificates of proficiency will be given to students who show themselves after two terms' work at the school and two seasons' practical work in cheese factory or creamery to be efficient in factory or creamery work.

Cost: Registration fee, \$15; board and room per week, \$3.50; two white suits, \$2.

(b) Instruction in farm dairying is given in a short special course in agriculture. Lectures and practical work are given twice a week for sixteen weeks.

(c) A six weeks' course in early summer is offered to women, dairying and other subjects being given. The only expense of this course is \$3.50 per week for board.

Buildings: Dairy Hall, specially erected for this purpose, is a large building containing rooms for instruction in butter and cheese making, pasteurizing and testing milk, also lecture rooms, reading room, and dressing rooms.

Equipment: Complete and modern appliances and machinery necessary to the courses of instruction described.

Other facilities: A large herd representing three different breeds and the best types of grade dairy stock supplies part of the milk used at the school.

MISSISSIPPI.

Mississippi Agricultural and Mechanical College, Agricultural College.

[S. D. Lee, president; W. C. Welborn, M. S., professor of agriculture.]

For information concerning dairy instruction, address Prof. W. C. Welborn, Agricultural College, Miss.

A regular short dairy course is not offered, but instruction in dairying is given in the agricultural course. Work in the creamery is offered to any desiring it, who make special arrangements with the professor of agriculture.

Cost: Tuition, free; board and room per week, \$2.

Equipment for giving dairy instruction consists of a regularly equipped creamery and large herd of dairy cows.

MISSOURI.

College of Agriculture and Mechanical Arts of the University of Missouri, Columbia.

[R. H. Jesse, LL. D., president; H. J. Waters, B. Agr., dean; F. B. Mumford, M. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. H. J. Waters, Columbia, Mo.

A special course in dairying is not offered. Three weeks of practical work in farm dairying is given in connection with the twelve weeks' winter course in agriculture, which begins early in January. A person can attend for these three weeks only if he is unable to take the complete short course. The dairy instruction consists of twenty lectures, supplemented by practical work in the care of milk and butter making. With the dairy work, subjects allied to dairying may also be taken, as lectures on stock breeding and feeding, selection and management of a dairy herd, dairy chemistry, and bacteriology.

Applicants must be 16 years of age or older.

Cost: Laboratory fee, \$5; board and room per week, \$3.50.

Equipment: A dairy building is equipped with Babcock testers, apparatus for pasteurizing milk and cream, and different styles of hand-power machinery for separating milk and making butter.

Other facilities: A herd of twenty thoroughbred Jersey cows is kept for illustration and practice in judging dairy cattle.

MONTANA.

The Montana College of Agriculture and Mechanic Arts, Bozeman.

[Rev. James Reid, B. A., president; Frank Beach, B. S., professor of agriculture.]

For information concerning dairy instruction, address President James Reid, Bozeman, Mont.

No regular short course in dairying is offered. Some dairy instruction is given, however, in the agricultural course, and arrangements can be made to attend for this instruction for a brief period between September and June.

Cost: Entrance fee, \$10; board and room per week, \$4.

NEBRASKA.

The Industrial College of the University of Nebraska, Lincoln.

[George E. MacLean, Ph. D., LL. D., chancellor; Charles E. Bessey, Ph. D., dean; T. Lyttleton Lyon, B. S. A., professor of agriculture; A. L. Haecker, instructor in dairying.]

For full information concerning dairy instruction, address Prof. T. L. Lyon, Lincoln, Nebr.

Dairy course: A twelve weeks' course in farm dairying is offered, commencing

early in January. Instruction will consist of lectures on dairy methods and closely allied subjects, supplemented by practical work in butter making and milk chemistry.

Cost: Fee, \$1; board and room per week, \$2.75; white suits, \$2.

Equipment: A dairy house has just been completed; it contains a large work room and two class rooms. Apparatus consists of hand separators, deep-setting cans, and necessary utensils for making butter as in a home dairy.

NEVADA.

School of Agriculture of the Nevada State University, Reno.

[Joseph E. Stubbs, M. A., D. D., LL. D., president; R. H. McDowell, B. S., professor of agriculture.]

For information concerning dairy instruction, address Prof. R. H. McDowell, Reno, Nev.

No regular dairy course is offered. Some dairy instruction is given by lectures in the agricultural course, and practical work with the Babcock tester is also given. Arrangements can be made to attend for twelve weeks in the fall to receive instruction by lectures and practical work in a creamery.

Cost: Tuition, free; board and room per week, \$4.00; two white suits, \$2.00.

Equipment: A Babcock tester and use of a public creamery at Reno.

NEW HAMPSHIRE.

New Hampshire College of Agriculture and the Mechanic Arts, Durham.

[C. S. Murkland, M. A., Ph. D., president; Charles H. Pettee, M. A., C. E., dean; F. William Rane, B. Agr., M. S., professor of agriculture.]

For information concerning dairy instruction, address President Charles S. Murkland, Durham, N. H.

Dairy courses: A course in creamery and farm dairy work extends throughout the winter term for regular students in the college, and any four continuous weeks thereof for special students. Instruction is given by lectures, demonstrations, and practical work. Dairy husbandry, milk testing and pasteurizing, butter making, dairy bacteriology, dairy engineering, and the care of animals receive special attention. Certificates are granted upon the satisfactory completion of the term's work.

Cost: Fee, \$5; board and room per week, \$1; two white suits, \$2.

Equipment: A creamery building is fitted with various styles of apparatus necessary for making butter and pasteurizing and testing milk.

Other facilities: A herd on the college farm contains typical animals of four different breeds and grades.

NEW JERSEY.

Rutgers Scientific School, the New Jersey State College for the Benefit of Agriculture and the Mechanical Arts, New Brunswick.

[Austin Scott, Ph. D., LL. D., president; E. B. Voorhees, M. A., professor of agriculture.]

For information concerning dairy instruction, address Prof. E. B. Voorhees, New Brunswick, N. J.

A special short dairy course is not offered. Instruction in dairying is given in the regular agricultural course.

Equipment: A dairy house fitted with modern dairy apparatus, and a laboratory fitted for testing dairy products.

NEW MEXICO.

In New Mexico no instruction in dairying is offered at the State College, located at Mesilla Park.

NEW YORK.

College of Agriculture of Cornell University, Ithaca.

[Jacob G. Schurman, D. Sc., LL. D., president; Isaac P. Roberts, M. Agr., professor of agriculture and dean; H. H. Wing, M. S., professor of animal industry and dairy husbandry.]

For information concerning dairy instruction, address Prof. I. P. Roberts, Ithaca, N. Y.

Dairy courses: (a) A winter dairy course of eleven weeks is offered, commencing early in January. It is especially designed to meet the needs of creamery and cheese factory men who desire more thorough instruction and to train those who expect to make butter and cheese making a profession. One lecture on dairying is given throughout the course, at 8 o'clock each morning. The management of the dairy and the operations in butter and cheese making are explained, the business management of the factory, dairy mechanics, and the care and breeding of cattle are discussed; from 9 to 10 o'clock various subjects more or less intimately related to dairying are discussed. At 10 o'clock each morning practical work is commenced, being so arranged that each student spends two days a week on each branch, viz, butter making; cheese making; and milk testing, problems, and bookkeeping. Certificates of proficiency are awarded to all who successfully complete the dairy course and one full season at an approved creamery, cheese factory, or dairy.

Applicants must be at least 17 years of age and possess a common school education. Cost: Fee, \$15; deposit to cover breakage (returnable), \$4; board and room per week, \$3.50; two white suits, \$2.

(b) Instruction with special reference to the needs of the farm dairy is given in connection with the winter course of agriculture.

Buildings: A building was erected in 1893 especially for instruction in dairying and can accommodate 50 students. It contains an engine room, rooms for instruction in butter and cheese making, laboratories for milk testing, and special work; also a large lecture room, reading room, and dressing rooms.

Equipment: Various styles of all modern dairy appliances and power necessary for their operation.

Other facilities: A herd representing three different breeds and containing some high-grade animals furnishes part of the milk used at the school.

NORTH CAROLINA.

The North Carolina College of Agriculture and Mechanic Arts, Raleigh.

[Alexander Q. Holladay, president; B. Irby, M. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. B. Irby, Raleigh, N. C.

A regular dairy course is not offered, but special instruction in testing milk and making butter and cheese in small amounts is given to any who apply for it during the session.

Cost: Tuition, per month, \$2; board and room per week, \$2.50.

Equipment: A dairy building fitted with apparatus for testing milk and making butter.

NORTH DAKOTA.

North Dakota Agricultural College, Fargo.

[J. H. Worst, president; J. H. Shepperd, M. S. A., professor of agriculture; E. E. Kaufman, professor of dairying.]

For full particulars concerning dairy instruction, address President J. H. Worst, Fargo, N. Dak.

Dairy course: (a) A course of twelve weeks, beginning early in January, is offered to any who desire to become more proficient in creamery work. Lectures are given on the principles of dairying, including the handling of milk, manufacture of butter and cheese, chemistry and bacteriology of the dairy, and management of cattle.

Cost: Tuition, free; board and room per week, \$3; fees, \$5.

(b) A one year's course is designed to meet the requirements of those who have had no previous experience in creamery work. The entire field of practical dairying is covered in the course, which includes careful training in all the details of management of a creamery or farm dairy.

Cost: Tuition, free; board and room per week, \$3; fees, \$5.

Equipment: A model creamery, with cheese room attached, is equipped with power and all the apparatus necessary either to a creamery or cheese factory. Accommodations are limited to twelve students.

OHIO.

Ohio State University, Columbus.

[James H. Canfield, LL.D., president. College of Agriculture, Thomas F. Hunt, M. S., dean; H. J. Noyes, assistant professor of dairy husbandry.]

For full information concerning dairy instruction, address Prof. William R. Lazenby, Columbus, Ohio.

Dairy courses: An eleven weeks' course in dairying begins each year, early in January. Butter making, as practiced in the creamery and farm dairy, is thoroughly taught. The principles of cheese making are given, together with some elementary practice. Instruction by lectures includes dairy cattle and their management, manufacture of dairy products, dairy chemistry and bacteriology, and the care of the engine.

Candidates for admission must be at least 15 years of age. Those under 21 must pass an examination in grammar, geography, arithmetic, and United States history.

Cost: Fees, \$15; room and board per week, \$3; two white suits, \$2.

Equipment. The dairy laboratory and work room is situated in the basement of Chemical Hall. It is well supplied with modern appliances for testing milk and the manufacture of butter and cheese.

Funds for the erection of an agricultural hall have recently been appropriated, and liberal provision will be made in the new building for dairy instruction. It is hoped to have it ready for occupancy in 1898.

Other facilities: A dairy of thirty cows, and a large farm equipped for investigations in stock feeding.

OKLAHOMA.

Oklahoma Agricultural and Mechanical College, Stillwater.

[G. E. Morrow, M. A., president and professor of agriculture.]

For full information concerning dairy instruction, address President G. E. Morrow, Stillwater, Okla.

A special dairy course is not offered. Instruction in dairying is given, however, in the regular course of agriculture, and one can attend for a period of six weeks during the winter term by making special arrangements. Work consists of milk testing, butter making and cattle feeding.

Cost: Tuition, free; board and room per week, \$3.

Equipment: A small dairy room fitted with butter-making and milk-testing apparatus; there are also some facilities for work in bacteriology.

OREGON.

Oregon State Agricultural College, Corvallis.

[H. B. Miller, president; H. T. French, M. S., professor of agriculture; F. L. Kent, B. S. A., instructor in dairying.]

For full information concerning dairy instruction, address Prof. H. T. French, Corvallis, Oreg.

Dairy course: Instruction in farm dairying is given in connection with the farmers' short course, which commences early in January and continues four weeks.

Cost: Tuition, free; room and board per week, \$2.50.

Equipment: A dairy building is furnished with tester, separator, and appliances for making butter in small amounts.

Other facilities are furnished for studying and judging dairy stock; three breeds are represented in the college herd.

PENNSYLVANIA.

The Pennsylvania State College, State College.

[George W. Atherton, LL. D., president. School of Agriculture, Henry Prentiss Armsby, Ph. D., dean; Harry Hayward, B. S., instructor in dairy husbandry.]

For information concerning instruction in dairying, address "The Dean of the School of Agriculture," State College, Center County, Pa.

Dairy courses: (a) A creamery course opens early in January and continues six weeks. It is designed for those especially interested in the manufacture of butter in creameries. Forty-eight lectures are given on butter making, dairy chemistry and bacteriology, dairy bookkeeping, breeding, feeding, care and diseases of dairy stock, and the management of dairy machinery. Practical butter making on a creamery scale is a daily exercise.

(b) A private dairy course is conducted for six weeks, commencing in the middle of February. It is designed to fit men for the management of the private dairy. Sixty-eight lectures are given on dairying, dairy chemistry, crops, dairy breeds of cattle, their care, selection, and feeding, and veterinary science. These lectures are supplemented by practical work in the dairy and barn.

Cost: Fee, \$5; board and room per week, \$4.50; two white suits, \$2.

Buildings: Class-room work is conducted in a temporary agricultural building. The practical instruction is given in the college creamery, which is in operation throughout the year and in which instruction is offered to a few at any time. Forty students can be accommodated at one time.

Equipment: All the apparatus necessary for a creamery and farm dairy, also a pasteurizing outfit.

Other facilities: Herds representing three breeds are kept on the station and college farms and used for scoring and judging dairy cattle.

RHODE ISLAND.

Rhode Island College of Agriculture and Mechanic Arts, Kingston.

[John H. Washburn, Ph. D., president; Arthur H. Brigham, professor of agriculture.]

For full information concerning dairy instruction, address Prof. Arthur A. Brigham, Kingston, R. I.

No regular short dairy course is offered. Arrangements can be made previous to the winter term to attend during that term a course of lectures on dairying given twice a week to seniors in the agricultural course.

Cost: Tuition to Rhode Island students, free; board and room per week, \$3.50.

Equipment: A dairy department has been projected and funds appropriated for purchase of dairy stock and apparatus.

SOUTH CAROLINA.

Clemson Agricultural College, Clemson College.

[E. B. Craighead, president; ———, professor of agriculture.]

For full information concerning dairy instruction, address Prof. J. W. Hart, Clemson College, S. C.

A special course in dairying is not given, but instruction in practical dairy work is offered to any who apply. Butter or cheese is made daily throughout the year.

Cost: Fee, free; board and room per week, \$4.

Equipment: A building especially constructed for dairy work is equipped with power and the necessary apparatus for testing milk and making butter and cheese according to the most approved methods. It can accommodate thirty students at one time.

Other facilities: A herd of eighty cattle, representing three pure breeds and their grades, furnishes the milk used in the dairy building.

SOUTH DAKOTA.

South Dakota Agricultural College, Brookings.

[John W. Heston, A. M., Ph. D., LL. D., president; E. A. Burnett, B. S., professor of agriculture; J. M. Trueman, B. S., assistant professor of dairying.]

For full information concerning dairy instruction, address Prof. J. M. Trueman, Brookings, S. Dak.

Dairy course: (a) A three months' course in creamery methods is offered in the winter term, beginning about the middle of November. It is designed to give full instructions in the principles and practice of creamery management. The lectures treat of the breeding and care of dairy animals, composition and testing of milk, theory of butter making, and dairy mechanics. Practical work consists of milk testing and other laboratory work and butter making three times per week.

(b) The course described above is repeated in the spring term

(c) A three months' course in cheese making is offered in the fall term, beginning the latter part of August. Instruction is given by lectures and daily practical work.

A certificate is given after satisfactory completion of the course and four months' practical work in a creamery or cheese factory.

Cost: Tuition, \$1; board and room per week, \$2.50; two white suits, \$2.

(d) Farm dairying is given in the spring term to the regular students in agricultural and the young women in the course of domestic economy.

Equipment: A building is fully equipped with apparatus for testing milk and making butter and cheese in large and small quantities.

TENNESSEE.

State Agricultural and Mechanical College of the University of Tennessee, Knoxville.

[C. W. Dabney, jr., Ph. D., LL. D., president; C. F. Vanderford, professor of agriculture.]

For information concerning dairy instruction, address Prof. C. F. Vanderford, Knoxville, Tenn.

No regular short dairy course is offered. Instruction in dairying is given in the agricultural course, special attention being given to milk for immediate consumption.

Equipment: A herd representing three different breeds with selected grades.

TEXAS.

State Agricultural and Mechanical College of Texas, College Station.

[L. S. Ross, president; J. H. Connell, M. S., professor of agriculture.]

For information concerning dairy instruction, address Prof. J. H. Connell, College Station, Tex.

A regular short dairy course is not offered. Instruction in dairying is given, however, in the regular agricultural course. Special arrangements can be made to attend for a period of twelve weeks between September and March and receive instruction in butter and cheese making, handling milk, and breeding and feeding cattle. Butter is made on the dairy farm daily.

Cost: Tuition, free; board and room per week, \$3.

Equipment: Milk testers and all the apparatus necessary for making butter and cheese in large and small quantities.

Other facilities: A large herd of cows and silos.

UTAH.

Agricultural College of Utah, Logan.

[J. M. Tanner, president; Paul Fischer, B. Agr., D. V. M., professor of agriculture;
F. B. Lintfield, B. S. A., professor of dairying and animal husbandry.]

For full information concerning dairy instruction, address Prof. Paul Fischer, Logan, Utah.

Dairy course: A ten weeks' course in agriculture and dairying commences early in January. Five exercises a week are given on the composition of milk and methods of testing it, butter and cheese making, and dairy cattle. Cheese is made once and butter twice each week.

Cost: Tuition, \$2.50; board and room per week, \$2.50.

Equipment: The dairy room is furnished with power and contains machinery for making butter and cheese in large and small amounts and testing milk.

VERMONT.

University of Vermont and State Agricultural College, Burlington.

[M. H. Buckham, D. D., president; J. L. Hills, B. S., professor of agricultural chemistry.]

For full information concerning dairy instruction, address Prof. J. L. Hills, Burlington, Vt.

Dairy course: A four weeks' course in creamery work is offered in January. Instruction is given in butter making and testing and pasteurizing of milk and cream. In the lecture course it is endeavored to cover briefly the entire field of dairying. The physical and chemical properties of milk receive special attention.

Certificates are granted upon the satisfactory completion of the term's work.

Cost: Tuition, free; board and room per week, \$4; two white suits, \$2.

Equipment: The dairy building is equipped as a creamery, and contains several styles of the different kinds of machinery employed in making butter, also milk-testing machines and pasteurizing apparatus. Accommodations are limited to fifty students.

Other facilities: Herd of forty cows, Jerseys and their grades and Ayrshires. Dynamometer and steam-consumption apparatus for testing power consumed by apparatus.

VIRGINIA.

Virginia Polytechnic Institute, Blacksburg.

[J. M. McBryde, Ph. D., LL. D., president; D. O. Nourse, B. S., professor of agriculture;
Wm. D. Saunders, assistant professor of dairy husbandry.]

For full information concerning dairy instruction, address Prof. D. O. Nourse, Blacksburg, Va.

A special dairy course is not offered. Any desiring instruction in dairying for a short period will be permitted to join the class in the regular agricultural course in February. The work continues about three months.

Cost: Tuition, State students, free; board and room per month, \$9.

Equipment: A creamery and cheese factory has recently been erected and fitted with all the apparatus necessary for making butter and cheese. It will be run throughout the year as a creamery on a commercial basis.

Other facilities: Four breeds of stock are represented in the herd.

Hampton Normal and Agricultural Institute, Hampton.

[H. B. Frissell, principal.]

For full information concerning dairy instruction, address C. L. Goodrich, Hampton, Va.

It is proposed to organize a systematic course in dairying next year.

Work in the dairy is performed by the students.

Cost: Tuition, free; board and room per week, \$2.50.

Equipment: A gravity creamer, separator, apparatus for making butter and testing milk.

Other facilities: A herd of cows supplies the milk used at the school.

WASHINGTON.

Washington Agricultural College and School of Science, Pullman.

[E. A. Bryan, M. A., president; William J. Spillman, M. S., professor of agriculture; Adolph Schoenmann, instructor in dairying.]

For full information concerning dairy instruction, address President E. A. Bryan, Pullman, Wash.

Dairy course: An eight weeks' dairy course begins about the middle of February. Two or three lectures are given daily; they treat of the care of dairy cows, practical dairy operations, management of factories, and dairy mechanics. About four hours a day is given to practical work, butter making receiving special attention the first four weeks and cheese making the remaining four weeks. It is recommended that students have some practical experience in dairy work before entering the school.

Cost: Tuition, free; board and room per week, \$3.

Equipment: A creamery and cheese factory building is fully equipped with modern machinery and power necessary for making butter and cheese and for testing milk.

Other facilities: A herd of cows on the college farm supplies part of the milk used at the school.

WEST VIRGINIA.

West Virginia University Morgantown.

[J. L. Goodknight, D. D., president; L. C. Corbett, B. Agr., B. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. L. C. Corbett, Morgantown, W. Va.

Dairy course: A regular short dairy course is offered in connection with the agricultural course in the winter term of twelve weeks. Instruction is given on the management of dairy cattle, butter and cheese making, milk testing, and creamery building.

Cost: Tuition, free; board and room per week, \$3; incidental fee, \$2.50.

Equipment: Suitable apparatus for giving instruction as outlined.

WISCONSIN.

College of Agriculture of the University of Wisconsin, Madison.

[Charles K. Adams, LL. D., president; W. A. Henry, B. Agr., dean; E. H. Farrington, M. S., associate professor of dairy husbandry, in charge of dairy school.]

For information concerning dairy instruction, address Prof. E. H. Farrington, Madison, Wis.

Dairy courses: (a) A twelve weeks' course in creamery and cheese factory work commences early in December and covers instruction in practical butter and cheese making. The work begins each week day at 8 o'clock with a one hour's lecture on dairying or an allied subject, including the composition of milk and its products, dairy bacteriology, dairy bookkeeping, care of a boiler and engine, and other physical problems of the dairy, and the breeding, feeding, and diseases of the dairy cow. After the lecture the class is divided into three sections, assigned respectively to the laboratory, creamery, and the cheese factory, the assignments being changed every two days, so that each student receives instruction in each of the three divisions of work every week. The afternoon's work closes with one hour's instruction by lectures, discussions, and quizzes on the operations of the day and scoring of butter and cheese.

(b) A few weeks after the beginning of the work those students showing the most proficiency are placed in an advance section to carry on experimental factory operations.

(c) Pupils whose standings are entirely satisfactory are allowed to take the course in pasteurization of milk and cream, this instruction being given the last four weeks of the term.

Persons taking the dairy course must be at least 16 years of age, have a common school education, and have had at least four months' experience in a creamery or cheese factory before being admitted.

Examinations are held at intervals throughout the term. Certificates are given to students after they have satisfactorily completed the full course and worked at least two seasons of seven months each in a creamery or cheese factory, provided one of these seasons follows the dairy course and the candidate practically has charge of the factory in which he works, reports his work properly, and the condition of his factory is satisfactory to an inspector sent out by the university.

(d) Advanced dairy instruction is offered to those who have completed the regular course. It deals with matters beyond those of the regular course, and includes experimental work in butter and cheese making and bacteriology.

Cost: Fees, \$11; deposit to cover breakage (returnable), \$2; board and room per week, \$4; two white suits, \$3; additional fee required from non-residents of Wisconsin, \$16.

(e) The university creamery, which is in operation throughout the year, will accept at any time a few pupils without previous training, to be known as "working factory pupils," from whom no fees are asked. These are expected to remain from three months to one year, and have opportunity to become familiar with all dairy operations.

(f) Instruction in farm dairying is given to students pursuing the short course in agriculture. Daily practice is given in the separation of cream by deep-setting apparatus and hand separators; also in all the processes of making, printing, and packing butter.

Building: Hiram Smith Hall is entirely devoted to dairy instruction, accommodating one hundred pupils in the regular dairy course and one hundred more in the farm dairy course. It contains an engine room, creamery, cheese-making room, curing rooms, pasteurizing room, laboratories, room for instruction in farm dairying reading and lecture rooms, and dressing rooms.

Equipment: The building is equipped with different forms of apparatus for making butter and cheese in large and small amounts; also for pasteurizing and testing milk.

WYOMING.

College of Agriculture of the University of Wyoming, Laramie.

[Frank P. Graves, Ph. D., president; B. C. Buffum, M. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. B. C. Buffum, Laramie, Wyo.

A regular short dairy course is not offered. The principles of stock raising are covered in a general way by lectures in the agricultural course. Instruction in milk testing, analysis of milk and butter, butter making, and feeding will be given at any time to any who apply for it.

Cost: Tuition, \$2.50; board and room per week, \$4.



BULLETIN NO. 18.

(Dairy No. 11.)

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.

THE DAIRY INDUSTRY IN MISSOURI AND KANSAS.

BY

LEVI CHUBBUCK,
Special Expert Agent, Dairy Division.

Under the direction of
Dr. D. E. SALMON,
Chief of the Bureau of Animal Industry.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., May 25, 1897.

SIR: I have the honor to transmit herewith, for publication as a bulletin of this Bureau, the manuscript of a report prepared under the direction of Maj. Henry E. Alvord, Chief of the Dairy Division, by Mr. Levi Chubbuck, special agent of that division, on the development and present condition of the dairy industry in the States of Missouri and Kansas.

Mr. Chubbuck was for a time secretary of the Missouri State Board of Agriculture, and has been secretary of the Missouri State Dairymen's Association since its organization.

Very respectfully,

HON. JAMES WILSON,
Secretary of Agriculture.

D. E. SALMON,
Chief of Bureau of Animal Industry.

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THE DAIRY INDUSTRY IN MISSOURI AND KANSAS.

INTRODUCTION.

Not many years ago it was assumed that New England and New York, with perhaps a part of Ohio added, would be able to supply the American demand for dairy products. It was thought that dairying would be mainly confined to the territory indicated, notwithstanding the growth of other sections, because the conditions in the West and South, generally, were deemed so unsuited to this industry as to prevent its extension in those directions.

The development of the commercial and manufacturing interests of the East made it soon apparent, however, that the farmers of that region could not supply the demands of its teeming population for food products. Meanwhile emigrants from the Eastern States pushed westward, located in the wooded lands of Ohio and Indiana and on the prairies of Illinois, and then crossed the Mississippi to occupy the fertile lands of the great agricultural basin which includes the States of Missouri and Kansas.

Cows came with the settlers and found the natural pasturage and other conditions very favorable to stock raising and milk production. Dairy cattle rapidly increased, and the farmers soon had before them the problem of how to utilize their surplus milk. Eastern demand for butter and cheese was found to increase about as fast, and the recognized "dairy belt" was gradually extended to include Ohio, Indiana, Illinois, Michigan, Wisconsin, and Iowa. It was still maintained that south and west of these States dairying could not be successfully pursued. These views were also destined soon to be proved erroneous.

It is now safe to assert that a territory of nearly 100,000,000 acres within the limits of Kansas and Missouri offers as great possibilities for dairying as any equal area on the globe. Such possibilities can only become realities through the abandonment of many ideas as to what were once regarded essentials in dairying, as, for example, that flowing spring water and a reliable supply of ice must be had on every dairy farm; that dairying can be made profitable only with permanent pastures and cultivated grasses, and that the dairyman must be near the consuming market. It is now conceded that well and cistern water raised to the surface by windmill pumps is a satisfactory solution of the water problem; that the community factory system, with power

separator or the hand separator on the farm, for butter making, obviates the necessity for a farm ice supply; that far more cow food can be grown on an acre in corn, sorghum, millet, clover, and cowpeas than can be produced in pasture grass, allowing the cow to feed herself, thus making winter dairying more profitable than summer; and that the modern fast-freight refrigerator-car system of transportation for perishable products practically puts the dairymen of the West as close to the market as are those of the East. Hence, it should begin to dawn on the world that in Missouri and in her sister State on the west (Kansas) can be produced a large part of its supply of butter and cheese, of a quality unsurpassed and at a cost which will defy competition.

Regarding the suitability of this region for producing dairy goods of high grade, it is only necessary to state that Missouri butter shown at the Columbian Exposition of 1893 scored within one point of perfection, and that Kansas butter was one of the first prize winners. As to possibilities of production, if one-tenth of the total area of Missouri and Kansas should be devoted to dairying, with 4 acres to a cow, and the cows yield an average of 200 pounds of butter a year, there would be produced annually over 500,000,000 pounds of butter, which, at 10 cents a pound, would make \$50,000,000, to say nothing of the returns from the skimmed milk fed to calves, pigs, and poultry.

This, too, would mean an enormous increase in the value of farm property, because of better improvements, more careful saving of manure, and better system of farming, all of which almost invariably accompany the development of dairying.

Much more might be said as to the good effect of a development of the dairy industry; how it would result in decreasing the size of farms and consequently increasing the number, each with a set of farm buildings to be added to the total wealth of the community, shortening distances between neighbors, increasing school, church, and social facilities, building up towns as consuming centers, and many other advantages.

PRESENT STATE OF THE DAIRY INDUSTRY IN MISSOURI AND KANSAS.

OBSTACLES.

In recent years Missouri has not shown that growth in dairying that was expected. There are a number of reasons for this. One of the most potent is that the population of the State originated, to a considerable extent, in Kentucky, Tennessee, and the South Atlantic States, where, under former farming systems, the milking of cows and the making of butter were not regarded as a man's work and were considered of too small consequence to engage attention as a source of farm revenue. The average Missouri farmer clings pretty closely to the ways of his ancestors.

However, the low prices for horses and cattle that have prevailed

during recent years, decreasing returns from corn and grass lands and causing sheriff's sales, have been a convincing argument to many. Farmers see that dairying may keep one closely at home and prevent active participation in all the political meetings and campaigns, attendance at all public vendues, and going to town two or three times a week and for all day on Saturday. But when it brings in during the year more money than has been spent, and the farm in the meantime has been growing more productive because of the manure made and returned to the land, it is evidently not such a bad business after all.

This is being proven, too, by the success attained by a goodly number of farmers who have come from the Northeastern States and brought with them the idea that if they looked after the dimes the butter brought, the dollars would show up in the bank account. Then there are communities of German farmers always successful when they engage in dairying, thus proving conclusively that with proper care and skill dairying can be made profitable in Missouri.

Another serious hindrance to the development of the dairy industry in Missouri is the work done in recent years by firms of butter and cheese factory builders. The bad effects of this will continue to be felt for years to come. A decade or more ago conditions were ripe for a rapid development of the dairy industry in that State. The creamery "promoters" took advantage of the opportunity. The factory idea was new, and the people, being for the most part ignorant regarding dairying and the requisites for success and profitable returns, were easily induced, in scores of instances, to subscribe for stock in plants costing from \$5,000 to \$8,000, which could have been easily duplicated for \$2,000 to \$3,000. These plants, too, were in almost all cases of capacity much beyond the requirements of the communities in which they were located, and in many instances were placed where there was an almost entire lack of interest in the enterprise among the farmers. As a consequence, they could not be successful. As soon as the people of the communities found that they had been deceived or misled, which was usually before the creamery was ready for operation, they naturally regarded the business itself a failure and a fraud. This feeling spreading to the farmers, but few of them became patrons, and these in a half-hearted way. The cattle at hand were from stock long bred almost exclusively for beef, and, with inexperience in handling even selected animals as milch cows, it was impossible to realize the yearly returns which had been unscrupulously promised. Hence there was disappointment and discouragement at all points. The double load of excessive investment and inexperience soon broke down the enterprise.

As a result, dead creamery plants were to be found in almost every county of the State, causing great depression to the dairy industry as a whole. To these unprincipled "creamery sharks" is mainly due a direct loss to people in the State, largely farmers, of at least half a million dollars. The agriculture of the State at large suffered a loss very

much greater in the serious check given to the extension of dairying by the unsuccessful butter and cheese factories.

Another cause for these failures was that most of the early Missouri creameries were built upon the wrong plan. The dairy centrifuge had not been perfected or generally introduced, and the early factory was arranged on the cream-gathering plan, which, unless combined with the farm separator, is dependent upon conditions which are unattainable in the greater part of the State. Attempted changes to the separator system were expensive and disastrous. Still further, imitation butter appeared during the same period, and enormous quantities came into the markets of the State in disguised competition with butter, causing great reduction in the selling price of the genuine article.

Notwithstanding the discouragements which have thus attended the development of the dairy industry in Missouri, the present outlook (1896) is much more encouraging, and this in spite of the very low prices prevailing for dairy products.

The same conditions did not apply to hinder the development of dairying in Kansas. That State was settled at a later time; its farmers at first naturally followed grazing and grain growing. These continued to be the leading agricultural interests until a recent period, when dairying, under the creamery system, was successfully introduced and has been rapidly extended.

ADVANTAGES.

As already stated, Missouri and Kansas possess unsurpassed natural advantages for dairying. Their geographical position is unexcelled, for they escape the rigors of the northern winter and the ill effects of the intense heat of the States farther south. In the extreme northern portions of these two States continuous stabling of cows is required for but little more than four months in the year, and during this period there are not more than a dozen days so severe that the cows can not with perfect safety be turned out of doors for exercise and fresh air. From the northern border, through 300 miles of latitude to the southern line of Missouri, there is a constant shortening of the cold season, and in the southern portion cows can graze during a large part of the winter.

While such is the case, it must not be understood that shelter and winter feeding can be dispensed with. Too many of our farmers have made that mistake to a greater or less degree. But the practical and intelligent dairyman sees that such a climate imposes much less expense on the business for stabling and maintenance than is required by one of longer continued cold. Winter dairying can be carried on successfully. All the necessary conditions exist, including the easy and cheap production of an abundant supply of ensilage. Indian corn seems to be the cheapest and best general-purpose food for dairy cattle, whether harvested as ensilage or in dry form, and nowhere in the world can it

be grown to greater advantage than in Missouri and Kansas. In no other region can there be grown a greater variety of supplemental crops—red clover, cowpeas, sorghum, millet, and others—and these constitute the basis of excellent and cheap rations for dairy cows. Within these and adjacent States are grown flax and cotton, the seed of which is worked up in the extensive mills of St. Louis and Kansas City, thus giving the farmers the advantage of the oil meals for stock food at the lowest possible prices.

Another advantage given by the geographical position of Missouri and Kansas is that markets for dairy goods are to be found in almost all directions, with large distributing and consuming centers within their borders. As a matter of fact, the home market has never yet been fully supplied with butter and cheese of local production. The city of St. Louis alone consumes annually hundreds of tons of butter and cheese shipped in from other States.

TOPOGRAPHY.

The topography of this region may be briefly described.

MISSOURI.

If a line be drawn from the northeast corner of the State to the southwest corner, nearly all of the prairie country will be found north and west of this line. This section is divided into several drainage areas served by numerous streams and their branches, all making their way to the Missouri River, which flows through the center of the State. On the lowlands along these streams the early settlers found abundant timber, and a dense growth of prairie grasses upon the uplands. The general surface is rolling, with an exceedingly small proportion of waste land. This is a region of unsurpassed agricultural resources, having an easily worked, fertile soil, with timber enough for home use, and being well watered and well supplied with railroads. Southeast of the line before mentioned, particularly south of the Missouri River, is the Ozark Mountain region. This is an extensive plateau, traversed by the St. Louis and San Francisco Railroad along its highest elevation from St. Louis to the southwest corner of the State. There is a much larger proportion of waste land in this part of the State, but much of that which is regarded as of little value for cropping affords good pasturage and will in time be the home of vast numbers of cows. Land is cheap, and with the mild climate this should be an ideal place in which to raise calves for dairy cows, a business which can be made very profitable.

KANSAS.

Kansas is much less diversified. The extreme eastern part of the State is generally rolling prairie, like western Missouri, with some timber along the streams. To the westward the timber decreases and disappears, and the grasses change to the varieties adapted to the

arid and semi-arid plains. The map at page 14 shows the creameries of Kansas to be mainly found at present in the eastern and eastern-central parts of the State, but they are being rapidly established farther westward. A few years ago the thought that dairying could be made profitable in this region would have been generally regarded as absurd. At the present rate of development it will not be many years before Kansas will appear almost as thickly dotted with creameries as Iowa is to-day.

METHODS OF FEEDING.

The general practice of dairy farmers in both Missouri and Kansas is to pasture their cows during the summer. The soiling system is practiced to a very limited extent, although there is a growing tendency in that direction. At present the practice is to grow a field of fodder corn or sorghum to be cut green and fed to the cows when pastures begin to get short from drought. The feeding of grain to the cows while on pasture, though as yet but little practiced, is growing in favor. Wheat bran can usually be bought for \$10 and ship stuff (middlings) at about \$12 a ton. Oil-cake (linseed) meal costs from \$20 to \$25 a ton. The use of a little of these foods at night and morning is found by the dairymen to help out the pastures, keep up the milk flow, and maintain the cows in good condition. With many it takes about four acres of land to winter and summer each cow. Others are feeding so that they can make one-half that area of land do the work, while a few have learned that by means of the soiling system for summer and the silo for winter feeding, properly supplemented with grain, they can make one acre furnish as much cow food as was formerly done by four.

PASTURE.

Blue grass (*Poa pratensis*) is the favorite pasture grass, its chief merit being in its characteristic early and late growth, thus prolonging the pasture season. In fact, with sufficient land in blue grass, one can have pasturage the greater part of the year. In this climate, after the seed stalk is thrown up, which is early in the spring, there follows a dense growth of long, flexible blades, which on the approach of winter lie recumbent and continue green underneath, so that stock graze upon it whenever it is not covered too deep with ice and snow. In midsummer, when rains are infrequent, blue grass does but little good, particularly if it has been grazed closely in the spring. To the man who became possessed of large tracts of land when values were low, or who inherited an estate of broad acres, blue grass is the acme as a pasture grass. It enables such a person to keep a large amount of stock with small expenditure of labor. It is an unsurpassed stock food, rapidly producing flesh of excellent quality. As a dairy pasture nothing is better, giving to butter at all times of the year the rich June color which is so highly prized. But in these later days, when dairying

as well as all other lines of farming must be placed on a business basis, and interest on one's investment, which in most cases includes land ranging in value from \$50 to \$100 an acre, must be included in the expense account, the matter of two or three extra acres to a cow is important. It is found that to conform to the present low prices and small margins, blue grass comes far from meeting the requirements. If it would grow as one of a mixture of grasses it would be valuable in permanent pastures, utilizing land that can not well be cultivated; but it will submit to no joint occupancy of the land with other grasses. It will not stand close grazing, and, as before remarked, it makes little or no growth during midsummer, hence the dairy farmers of Missouri are depending less and less on blue grass for pasture. At present fully half of the pasturage is blue grass, but this is being fast replaced with timothy, orchard, and other grasses and clovers.

PASTURING HARVESTED CORNFIELDS.

The pasture season usually covers about seven months, extending from the middle of April to the middle of November. During the early part of winter a common practice is to turn the cows and other stock into the cornfields from which the grain has been gathered, the stalks having been left standing. Much of the fodder is eaten, together with such weeds and grass as may have been allowed to grow, and corn ears overlooked in the harvesting. If these stalk fields are thus utilized before there have been severe frosts and continued rains, the stock will gain something from them; otherwise, about all they get of value is the grain. More trouble and loss of neat stock is suffered from this practice than from almost all other causes. It is a practice of the general farmers rather than of the dairymen, for the latter have found that while stalk fields can be bought for 25 to 50 cents an acre, they do not supply profitable food when treated in this way.

FEEDING CORN FODDER.

If they raise corn themselves, it pays to cut the stalks before they are weather beaten, and put them into shocks 12 by 12 or 16 by 16 hills square. The general practice according to this plan is to husk out the corn and shock or haul to the barn and stack the fodder, feeding it uncut in the yard. Yet this affords very little gain over field feeding. Many are, however, buying fodder cutters or shredders, with which to cut or crush the fodder, and this is a most economical and commendable advance. Others do not husk the corn, but cut up stalks and ears together, thus feeding the grain with the fodder. If the earless stalks are cut, the short fodder is usually moistened and mixed with ground grain, bran, ship stuff, and a little oil meal, making a mixture that is readily eaten by cows, with very little waste. By these methods of utilizing the corn fodder, many dairy farmers are proving the correctness of experimental results published by the agricultural

stations in several States, which show that the stalks or fodder of an acre of corn contain as much nutrition as the grain from the same land. The only work necessary to make this food material available and profitable is to put it into such mechanical condition that cattle will consume it without waste. With modern methods and appliances this can be easily done. Uncut corn fodder is troublesome to handle in the barn, and if fed loosely in the yard most of it is wasted. The writer has fed corn to cows during the past winter in a way that is quite satisfactory. Stalls were made, each for two cows, but with a simple, long manger, so wide and deep that an armful of uncut corn could be laid in at full length. Ears were not removed from the stalks, thus feeding to the cows the entire corn plant (minus the root), with no labor or preparation, and saving the cost of husking, shelling, and grinding the grain and cutting the fodder. The stalks are not eaten as closely as when run through a fodder cutter or shredder, yet when a comparatively small stalked variety is grown, and the corn cut at the proper age, the amount of refuse is surprisingly small. Considerable unmasticated and undigested corn passes through the cows, but with pigs to clean up after them this need cause no waste. After having fed corn in the different ways recommended, this method generally suits so well that the fodder cutter often stands idle in the winter. Other grain has been fed separately to balance the too carbonaceous corn, with occasional feeds of sorghum fodder, millet, and clover hay. The results have been very satisfactory as to the condition of the cows, their milk flow, and the cost of keeping and labor.

If properly managed, the corn fodder, which heretofore in the corn-growing States of the West has been largely wasted, can be converted into cow food of almost incredible value. There are grown yearly in Missouri over 6,000,000 acres of corn. Of this less than half is cut up for fodder, so that at least 3,000,000 acres of corn fodder are practically allowed to go to waste. This is enough to winter, on a liberal allowance and with other feed in proper proportion, 1,000,000 cows, which, if fresh in the autumn, could be made to yield a profit of \$10 a head from this winter's feeding, making a total return of \$10,000,000.

FEEDING WHEAT STRAW.

Another article of cow food produced largely in Missouri and Kansas is wheat straw; but this is wasted for the most part and in many cases burned. When fed, the usual custom is to let stock run to the stack of straw in winter, eating what they want, but wasting more. Probably a million tons of wheat straw are thus wasted annually in Missouri. Although this material is far from being as nutritious as cornstalks, it furnishes bulk and has some food value; if properly balanced with bran, oil meal, and clover hay, this straw would keep through the winter at least 500,000 head of cows.

What is true in these respects of Missouri is correspondingly

applicable to Kansas, both being corn-growing States and having also a large acreage of wheat.

In no other way can this enormous quantity of stock food, corn fodder, and wheat straw, now wasted, be utilized to so good advantage as by feeding to cows. No other class of stock will eat it so readily or make so good returns for it, if given proper shelter, daily care, and the supplemental grain food necessary to fully utilize these coarse materials.

WATER SUPPLY.

An adequate supply of good water is a requisite for success in dairying, but all of our Western dairymen have not fully recognized this important matter. It is true that there are natural obstacles to providing such a supply. Excepting the Ozark region of south Missouri, flowing springs are not found as commonly as in the hill countries of the Northeastern States, yet the farmers of Missouri and Kansas have it within their power to secure an adequate supply of pure water.

Wells are easily dug or bored, and at depths varying from 30 to 75 feet—usually at less than 50 feet—an abundance of pure water is found. This can be raised to the surface by windmills or hand pumps, thus furnishing water for the stock and for use in the dairy. Many dairymen have arrangements by which a windmill raises the water, and it flows through a pipe into the dairy house, filling a tank in which the milk is set. The water is kept fresh and the overflow runs to troughs in the stock yards and barns for the use of the animals. A much larger number of farmers, however, depend on surface ponds for stock water supply. As usually made and cared for, these are quite objectionable. It should be explained that underlying the soil of most of this Western prairie country there is a clay or hardpan which is quite impervious to water. By choosing a place on a hillside, removing the surface soil and clay and making a dam on the lower side, a basin is formed which catches water from the shed above. Properly located so as to get the water from grass land, and fenced to prevent stock from getting into it, this water is pure and good, although not as clean as well water. In winter it is too cold for cows, and in summer too warm to be palatable. These two objections can be overcome by providing a cistern into which the water from the pond is conducted, passing it through a filter of sand and charcoal. From this cistern the water can be pumped to supply the stock. In too many cases, however, the shallow pond, filled with surface water drawn frequently from sources which contaminate the supply, and in which the stock is allowed to stand, is the only provision made for drinking water for the cows; hogs often have access to the same pool. This gets very warm and foul in summer, and in winter the cows are allowed to drink once a day or possibly only once in two days from holes cut through the ice. It is needless to say that men who attempt to keep dairy cows under such conditions are not advancing their own interests or those of the State.

CLASSIFICATION OF DAIRIES.

Dairying in Missouri may be classified as elsewhere: Farm butter dairies, creameries, cheese factories, milk dairies for local supply, others which furnish milk to more distant markets, and some dairy specialties.

FARM DAIRIES.

There is little that distinguishes the farm-dairy practice of Missouri from that of other States. Good butter makers are by no means the rule, and the product of the farms, which varies greatly in quantity



and quality, is generally of a low grade. Local markets take up the supply at very low prices, and much of the butter is shipped in wretched condition from the country stores and villages to dealers and manipulators, who "renovate" it as best they can and work it over into passably commercial forms. The milk from which this variegated farm product is made is originally good enough, of full average quality but the producing farmers lose half its value from ignorance of the art of home dairying or failure to join in cooperative effort or to patronize an established creamery. By far the greater number of farmers follow the old and apparently more natural practice of letting

their animals calve in the spring. As a consequence, while there is a great flow of milk for a short period, summer heat and drought tend to rapidly diminish the yield and shorten the milking period of the cows. July, August, and September are, in Missouri, the most unsatisfactory part of the year for milk production and for handling milk. Pastures are short, water is scarce, flies are troublesome, general farm work pressing, and prices of dairy products at their lowest point. Yet nine-tenths of the cows in the State are milked during this period, and most of them at an actual loss, besides infinite annoyance to their owners. Few of the farmers seem to appreciate the very great advantages which result from letting the cows go dry in July and having them calve during the autumn months. There are some, however, who follow this plan, and derive the full benefit of the natural conditions of this section, which favor winter dairying. It is evident that these cases are serving as object lessons, and others are following these good examples.

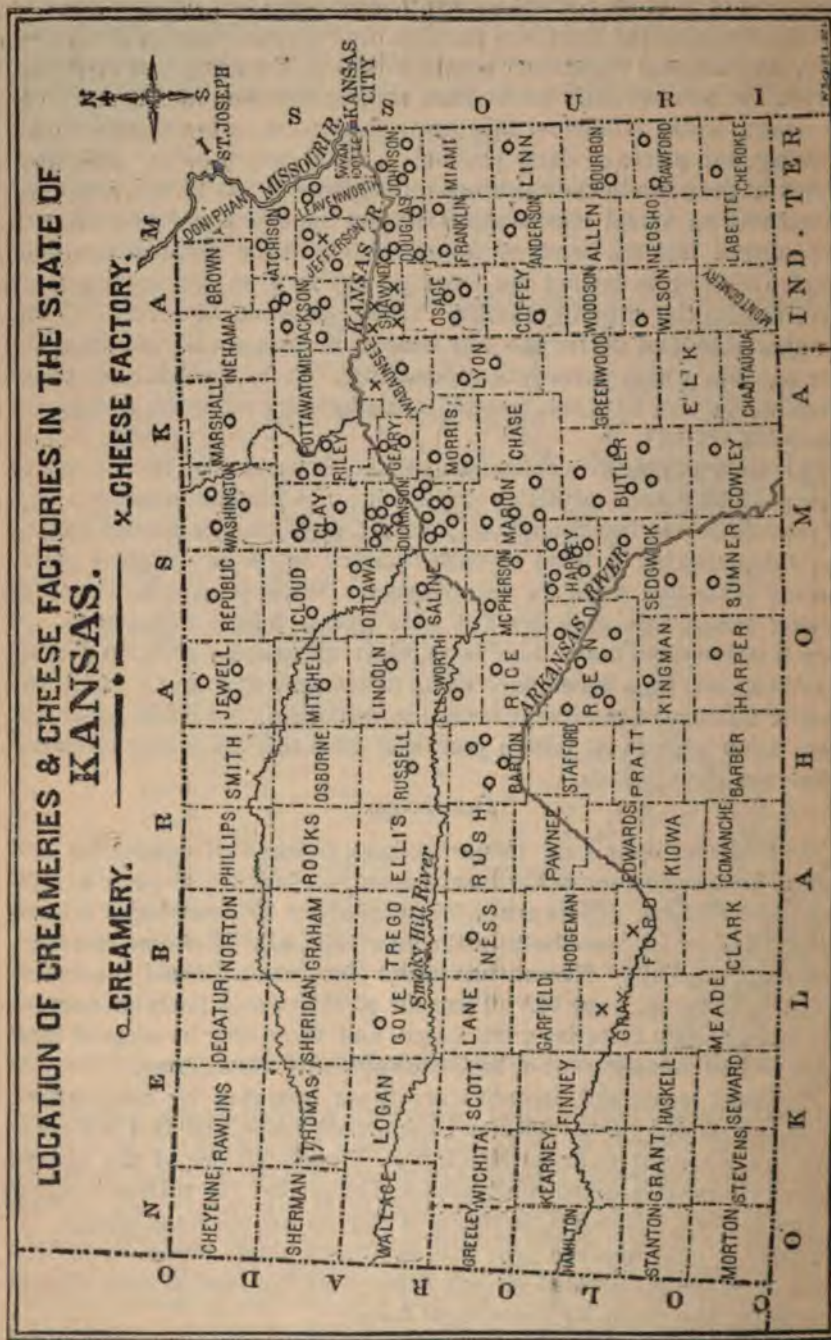
The most progressive dairymen of the State expect their cows to each yield 25 pounds of milk a day during the first one hundred days, 20 pounds during the second one hundred days, and 15 pounds during the third, making a total of 6,000 pounds in three hundred days, leaving sixty-five days for recuperation. With proper facilities for raising cream, this milk worked into butter makes 240 pounds. A very few dairymen make their cows yield an average of 7,500 pounds of milk a year, from which they make 300 pounds of butter. Much the greater number of cows kept for dairy purposes in the State yield less than 4,000 pounds of milk a year, and from this the butter produced is less than 150 pounds.

CREAMERIES.

Next to the individual butter makers, patrons of creameries and cheese factories comprise the most numerous class of dairymen in Missouri and Kansas. There are in Missouri about 100 creameries in operation, 15 of which were built in the year 1895, also 25 cheese factories. (See map, page 12.) Kansas has about 150 creameries and cheese factories. (See map, page 14.) The year of 1896 was a fairly prosperous one and but few factories were closed, and these only because of local causes—bad management or lack of support by the farmers.

The most successful factories are those operated by the owners. Some are on the cooperative and joint-stock basis, and in a few cases they are managed quite satisfactorily. Nearly all are of the modern type of creameries, using separators and skimming the milk as brought to the factory, although there are a few gathered-cream plants. It is probable that another year will not find a single creamery in Missouri or Kansas operated on any other than the mechanical plan of separating the cream by centrifugal force.

Skimming stations are established at points where considerable milk can be had, yet not enough to warrant putting in a complete plant. To



these the milk is hauled daily for separation and the cream is sent by wagon or rail to the central factory. By this method a much larger area of country can be handled, and success is much more certain than when the creamery must operate on a limited quantity of milk.

The development of the hand separator is changing the plan of operating creameries. Instead of the creamery being equipped with power separator and all the milk brought there for skimming, separators operated by hand or light power are being placed on the farms, the milk skimmed there, and only the cream delivered to the central factory, where it is ripened and churned into butter. This is a sort of combination of the advantages of the separator and of cream gathering and an improvement upon both. By this plan the farmers have the skimmed milk to feed to calves and pigs while yet warm and fresh, and the cost of hauling this to and from the factory is saved.

The factory in Missouri having the largest output of butter has but one separator, of the "Jumbo" pattern, and at times handles 14,000 pounds of milk a day. From the 4,640,834 pounds of milk received during 1895, 194,965 pounds of butter were made, and the patrons of the factory were paid \$29,640 during the year, on the fat-test basis.

The largest establishment of the kind in Kansas operates six factories, three of which have larger daily receipts of milk than any other in the State.

Another, organized in 1888, has now 13 factories and branches in operation in Kansas. This company, of which the secretary is president of the Kansas State Dairy Association, is the originator of the skimming-station idea in Kansas. It is putting in a number of these stations.

One of the great difficulties the creameries and cheese factories have to contend with is an insufficient supply of milk during a portion of the year, usually in winter, when they could be run to best advantage if the milk could be had. Nearly one-third of the factories have to close for about four months. The advantages in winter dairying, to both creamerymen and dairymen, are so marked, however, that, as already stated, the tendency is in that direction. It takes time to make this change in any dairy, even after the farmer has become convinced that it is desirable, the only quick way being to sell off the spring cows and replace them with those coming fresh in the fall. This is usually hard to do, from the fact that the latter class are scarce and high in price.

Some of the factories run three hundred and sixty-five days in the year, but in most cases the plants are not operated on Sundays, the farmers using the Sunday milk for supplying their families with butter.

Prices paid to patrons of creameries and cheese factories under different systems of buying milk have been reported as follows:

A creamery at Fairfax, Mo., making, in 1895, 10,102 pounds of butter and 5,880 pounds of cheese, paid per 100 pounds of milk, in

January, 80 cents; February, 72 cents; March, 64 cents; April to August, inclusive, 60 cents; September, 64 cents; October and November, 80 cents; December, 74 cents.

A creamery at Bethany, Mo., paid, on the butter-fat test: May, June, and July, 7 cents per pound; August and September, 8 cents; October, 11 cents; November and December, 12 cents.

A creamery at Holden, Mo., making 100,000 pounds of butter in 1895, paid, on butter-fat test: May, June, and July, 15 cents; August, 16 cents; September, 17 cents; October, 18 cents; November, 19 cents; December, 20 cents—equivalent to an average of 64 cents per 100 pounds of milk; and one at Smithton, Mo., paid an average of 65 cents per 100 pounds of milk.

At Concordia, Mo., a creamery paid an average of 17½ cents per pound of butter fat, and a cheese factory at Appleton City, Mo., paid an average of 75 cents per 100 pounds of milk.

The product of the creameries in Missouri is usually shipped to St. Louis, Chicago, and New York, nearly all being packed in 60-pound tubs.

The leading dairy counties of Missouri and Kansas are easily seen by reference to the maps.

CHEESE FACTORIES.

Cheese factories are not so popular in Missouri and Kansas as creameries, yet the demand for good cheese is better than that for butter. Most of the cheese made is sold from wagons sent out by the factories and making regular trips through the surrounding country. When purchased at stores, consumers have to pay from 12½ to 15 cents a pound for cheese which costs the merchants about 10 cents.

From the prices reported as being paid for milk by both cheese factories and creameries, cheese making seems to be fully as profitable as butter, both to factories and patrons.

The skimmed milk from the creamery is regarded as more valuable by the farmer, for feeding to calves and pigs, than is the whey from cheese making. The creameries usually sell the skimmed milk back to the farmers at 1 cent a gallon or 10 cents per hundred pounds. This is variously estimated by the farmers as being worth from 10 to 25 cents per hundredweight as food for growing stock.

The average quality of the cheese made in Missouri and Kansas is not as good, comparatively, as that of the butter from the creameries of these States.

MILK SUPPLY.

As is the case in most of the States west of the Mississippi River, cities and populous towns in Missouri are few and far between. With the exception of St. Louis, Kansas City, St. Joseph, Hannibal, Chillicothe, Sedalia, Jefferson City, Moberly, and Springfield, the towns are of a size and character which permit numerous residents to keep cows

for supplying their families with milk and butter. There will usually be found, however, in the vicinity of every county seat and of other towns of 1,000 population and over, one or more dairymen who make a business of supplying from wagon the local demand for milk. Such dairymen keep an average of about 10 cows in milk. Probably four-fifths of these animals are grade Shorthorns in blood, but many owners are introducing the Jerseys and rapidly grading up with this breed. About 3 per cent of the cows now are nearly pure Jerseys. The Holstein is a favorite with other dairymen, especially for milk production. About 1 per cent of the cows are of this breed.

The methods pursued by farmers who supply milk by wagon to near-by customers in villages and towns are those familiar in nearly all parts of the country. The milk is generally served by dipping from large cans, and is rarely properly cooled, if at all, before leaving the farms where it is produced. The producers and dealers in the towns are opposed to using bottles. They claim that the labor of filling and cleaning and the losses from breakage are too great, and that customers are unwilling to pay this additional cost.

The price of milk delivered to large consumers or small dealers ranges from 12 to 15 cents per gallon in summer and a cent or two more in winter. The retail price per quart is very generally 5 cents throughout the year.

Milk dairymen and dealers seem loath to change their methods of handling, and consumers do not encourage the introduction of innovations by paying more for a superior quality or patronizing dealers who make efforts to handle only pure milk. Very few aerators are in use in Missouri and Kansas. Dependence for cooling milk is mainly an open tank of cold well water, into which the cans are set after milking at night.

DAIRY SPECIALTIES.

An extensive business in making Swiss cheese is being developed at California, Mo. There are five factories in the county, one of which has been in operation twenty years. The others have been lately established. The annual output is now 125,000 pounds. Milk is delivered twice a day, for which 70 cents a hundred is paid, the whey being returned to the patrons. This cheese sells at 11 and 12 cents per pound for No. 1, and 9 and 10 cents for No. 2. It is shipped principally to Southern markets. Imitations of foreign kinds of cheese are not made in Kansas except in a very limited way; but a small amount of Swiss cheese is made at Enterprise.

There are no factories for condensing milk in Missouri or Kansas. One Missouri company, in connection with its other business, does something in this line at places in Illinois.

Pasteurized milk is prepared by a dairy company of St. Louis, at Highland, Ill., where the milk is produced. The bottled milk is sent by rail to St. Louis and delivered to customers at 10 cents per quart.

This company makes a special effort to secure pure and healthy milk. The dairy farms from which its supply of milk comes are regularly inspected as to the sanitary condition of the entire premises and the health of the cows. A dairy firm at Kansas City has a pasteurizing apparatus in their city depot. The product is sold in bottles at 6 cents a quart, being only 1 cent more than the regular retail price of milk not thus treated.

The application of science in such forms as the Babcock tester and the centrifugal separator, or skimming machine, to the old-fashioned business of dairying is doing much to revolutionize ideas and methods. With the adoption of improved apparatus for manipulating the product of the cows, the application of scientific principles in breeding and feeding them is also coming into practice.

INSPECTION.

The dairying of this section has not made much demand upon veterinary science for assistance, although there are those who believe that this will soon become necessary. Unquestionably there are numerous cases of tuberculosis among our dairy cattle. Missouri has an efficient veterinary service under the control of the State board of agriculture, but thus far it has not been empowered by law to deal with tuberculosis. The State board of health and the board of agriculture have had under consideration how to best bring about a veterinary supervision of the dairy stock of Missouri. The consumers of dairy products should be protected against the possible danger of contracting disease from milk, butter, or cheese containing germs of different maladies. Fighting disease on this line is a work which must be inaugurated and carried forward by State authority solely, probably for many years to come.

DAIRY SUBSTITUTES.

There is now in Missouri effective legislation against making and selling imitations of butter, but none controlling the manufacture and sale of filled cheese.

Kansas has no laws controlling the sale of imitation butter or filled cheese.

The last general assembly of Missouri enacted a law regarding frauds in dairy goods and their substitutes, and its enforcement was placed with the State board of agriculture, \$5,000 being appropriated to meet the expense for two years.

During 1895, the first year the law was on the statute books, only 70 government licenses were issued in the State, while the year before 450 had been issued. Of these 70, all but 10 were taken out in St. Louis and Kansas City. A number of prosecutions were made by the board for violations of the law, and in every instance where the cases came to trial the validity of the law was sustained.

As to the effect of this law, the following statements are made by men in St. Louis who are well qualified to give opinions:

Hofman Bros.: Since its enactment and the appointment of a local agent for enforcement, the sale of pure butter has materially increased. We are able to sell large quantities of farm dairy butter now, while prior to the enactment of this law it was almost impossible to sell anything but fancy creamery.

W. A. Hudson: We are pleased at the wonderful improvement in this market for butter the past six months. One year ago country roll was almost unsold at 5 to 8 cents per pound, and the same goods are now worth from 10 to 16 cents per pound and closely sold up. The law has been a great boon, chiefly to the small farmer, but also to the creamery. To show the necessity for this encouragement, this house alone has sent out of the State for butter as much as \$365,000 in one year, and it is estimated that this city sends out \$2,000,000 annually for dairy supplies. We really believe the effect of the new oleo law will benefit the farmers of Missouri the first year of its operation over \$1,000,000, and this benefit will increase year by year as the blighted industry will revive, until the \$2,000,000 sent out of this city will be paid to our own farmers.

William N. Tivy: The law has been of great benefit. The representations made to the governor and the senate when this law was under consideration have been verified and fulfilled. The production of pure butter has increased in this State and found sale at fair prices. The purchase of butter from Illinois, Wisconsin, Iowa, and other States, and the sending of large sums of money to them, must diminish and ultimately cease.

Hassendenubel Bros.: The benefit and effect so far of the enforcement of the oleo law have exceeded our expectations. If our legislators could spend an hour in some grocery store in the tenement district and see how these poor people were robbed by selling oleo at 25 to 30 cents a pound as pure butter, they would not doubt the justice of this law. Yes; the benefits and effects are great. Continue to protect the farmer and the workingman.

DAIRY ORGANIZATIONS.

The Missouri State Dairymen's Association was organized in the fall of 1890 on a call issued by Levi Chubbuck, then secretary of the Missouri State board of agriculture. The meeting for organization was held at Kansas City. The first annual meeting was held at Jefferson City January 15, 1891. The organization has had no direct help from the State for its work. It was through the personal efforts of its members that the passage of the anti-oleo law was secured last winter.

The Kansas State Dairy Association, J. L. Hoffman, Newton, Kans., secretary, is the only dairy or creamery organization in that State. The State Dairy Association worked for a law at the last session of the legislature and almost succeeded in getting a bill passed regulating the sale and manufacture of oleomargarine and imitation butter products, but the effort was defeated at the last moment. The State Dairy Association is greatly hampered in its work by lack of funds. All the aggressive campaigns against oleomargarine have been made with private subscriptions among members of the association.

APPENDIX.

CREAMERIES AND CHEESE FACTORIES IN MISSOURI AND KANSAS.

Creameries in Missouri—1896.

NORTHEAST SECTION.

County.	Name.	Post-office.	County.	Name.	Post-office.
Adair.....	Benben Davidson..	Brashear.	Lincoln.....	Truxton Creamery.	Truxton.
Do.....	John Patterson...	Kirksville.	Do.....	Do.....	Old Monroe.
Andrain.....	B. R. Cauthorn,	Mexico.	Do.....	Elsberry Creamery.	Elsberry.
Do.....	president.		Linn.....	W. B. Loomis.....	Meadville.
Do.....	Martinsburg.....	Martinsburg.	Pike.....	Louisiana Cream-	Louisiana.
Do.....	Vandalia.	Vandalia.	Do.....	ery.	
Callaway.....	Fulton Creamery...	Fulton.	Do.....	Frankford Cream-	Frankford.
Lewis.....	La Grange.	La Grange.	Do.....	ery.	
Do.....	Canton Creamery..	Canton.	Do.....	Paynesville Cream-	Paynesville.
Do.....	Monticello Cream-	Monticello.	Do.....	ery Co.	
Lincoln.....	ery.		Scotland.....	Clover Dale Cream-	Memphis.
Do.....	Moscow Creamery	Moscow Mills.	Do.....	ery Co.	
Do.....	Co.		St. Charles...	New Era Creamery	New Melle.
Do.....	Silex Creamery....	Silex.	Do.....	Co.	
Do.....	Winfield Creamery	Winfield.	Sullivan.....		Greencastle.
	Co.		Do.....		Harris.

NORTHWEST SECTION.

Andrew.....	J. J. Bateman.....	Empire Prai-	Dekalb.....	L. C. Frey.....	Amity.
Do.....	Rose Creamery....	rie.	Grundy.....	Edinburg.	Edinburg.
Do.....	Missouri Star	Savannah.	Do.....	Laredo.	Laredo.
Do.....	Creamery.	Rosendale.	Harrison.....	Bethany.	Bethany.
Do.....	Rea Creamery.....	Rea.	Do.....	Cainsville.	Cainsville.
Do.....	Helena Creamery..	Helena.	Do.....	Ridgeway.	Ridgeway.
Do.....	Mr. Rose (Savan-	Cawood.	Jackson.....	Blue Springs.	Blue Springs.
Do.....	nah).		Do.....	Westport.	Westport.
Do.....	Crosby Creamery...	Crosby.	Do.....	Hickman	Hickman
Atchison.....	Pine Hill Creamery	Fairfax.	Do.....	Mills.	Mills.
Do.....	(E. H. White).		Lafayette...	Corder.	Corder.
Buchanan.....	American Cream-	St. Joseph.	Do.....	Corder Creamery	Corder.
Do.....	ery Co.	Do.	Do.....	Co.	
Do.....	St. Joseph Cream-		Do.....	Concordia Cream-	Concordia.
Do.....	ery Co.	Do.	Do.....	ery Co.	
Carroll.....	Star Creamery Co..	Grace.	Do.....	Alma Creamery Co.	Alma.
Do.....	Co.		Do.....	Mayview Creamery	Mayview.
Do.....	Elm Hill Creamery		Do.....	Co.	
Do.....	Co.		Livingston..	Adams & Son.....	Chillicothe.
Do.....	Hale Creamery....	Hale.	Do.....		Dawn.
Do.....	Norborne Creamery.	Norborne.	Platte.....	Platte City.	Platte City.
Clay.....	Co.	Moscow.	Do.....	Woodruff.	Woodruff.
Dekalb.....	S. W. Cook & Son...	Mayville.			

SOUTHWEST SECTION.

Bates.....	Hume Creamery Co.	Hume.	Henry.....	Montrose Creamery	Montrose.
Do.....	Rockville.	Rockville.	Do.....	Co.	
Cass.....	Garden City Cream-	Garden City.	Johnson...	J. C. Bail (2 cream-	Warrens-
Do.....	ery.		Do.....	eries).	burg.
Do.....	East Lynne Cream-	East Lynne.	Do.....	Centerview Cream-	Centerview.
Do.....	ery.		Do.....	ery.	
Christian.....	Ozark Creamery....	Belton.	Do.....	Walter S. Dille...	Holden.
Dade.....	Lockwood Cream-	Ozark.	Do.....		Fayetteville.
Do.....	ery Co.	Lockwood.	Lawrence...	Freistatt Creamery.	Freistatt.
Do.....	Meinert Creamery	Meinert.			
	Co.				

Creameries in Missouri—1896—Continued.

SOUTHEAST SECTION.

County.	Name.	Post-office.	County.	Name.	Post-office.
Cape Girardeau.	Wm. B. Schaefer ...	Jackson.	Perry.....	Brewer Creamery Co.	Brewer.
Do.....	Appleton Creamery	Appleton.	Do.....	Plant and creamery.	Perryville.
Do.....	Pocahontas	Pocahontas.	Do.....	Altenburg Creamery.	Altenburg.
Do.....	Friedhelm	Friedhelm.	Do.....	Longtown Creamery.	Longtown.
Do.....	Gordonville	Gordonville.	St. Francois	Bonne Terre Creamery.	Bonneterre.
Franklin .....	.....	Villa Ridge.	St. Genevieve.	St. Genevieve Creamery.	St. Genevieve.
Do.....	.....	Washington.	Do.....	Bloomsdale Creamery.	Bloomsdale.
Jefferson	Hillsboro Creamery	Hillsboro.	Scott	New Hamburg Creamery.	New Hamburg.
Do.....	Jarvis Creamery ..	Jarvis.	Stoddard ..	Bloomfield Creamery.	Bloomfield.
Do.....	Jefferson County Creamery.	Hillsboro.	Washington.	Thos. A. Welch ...	Baryties.
Do.....	Seekman Creamery.	Seekman.			
Do.....	Chas. J. Hogan	Hematite.			
Do.....	Emanuel Hoffman ..	Vineland.			
Do.....	Herculeum Creamery.	Herculeum.			
Perry.....	Creamery Co.....	Frohna.			

CENTRAL SECTION.

Benton	New Creamery Co..	Cole Camp.	Pettis	Smithton Creamery Co.	Smithton.
Boone	Centralia Creamery Co.	Centralia.	Do.....	Georgetown Creamery Co.	Georgetown.
Do.....	Columbia Creamery	Columbia.	Saline	Sweet Springs Creamery Co.	Sweet Springs
Chariton	Wien Creamery Co.	Wein.			
Cooper	Lone Elm Creamery	Lone Elm.			

Cheese factories in Missouri.

NORTHEAST SECTION.

County.	Name.	Post-office.	County.	Name.	Post-office.
Knox	Jos. Taylor.....	Newark.	Sullivan	M. S. Parry.....	Green City.
Montgomery.	H. C. Lewelling ...	High Hill.	Do.....	do.....	Milan.

NORTHWEST SECTION.

Andrew	Lewis Sargent	Bolckow.	Clinton	Turney Cheese Factory.	Turney.
Caldwell.....	.....	Kerr.	Daviess .....	.....	Winston.
Do.....	.....	Cowgill.	Gentry	Berlin Creamery Co.	Berlin.
Do.....	— (McDaniel) ..	Kidder.	Do.....	King City Dairy Co.	King City.
Do.....	Prairie Gem Cheese Factory.	Cameron.	Holt	J. M. Clark.....	Mound City.
Do.....	McCrae Bros. Cheese Factory.	Do.	Nodaway...	Cole & Smith	Barnard.
Clinton	Moore & Moulton..	Do.			

SOUTHWEST SECTION.

Bates	Prairie City Factory.	Prairie City.	St. Clair	2 Appleton City cheese factories.	Appleton City.
Greene	Republic Cheese Factory.	Republic.	Do.....	Taberville Cheese Factory.	Taberville.

CENTRAL SECTION.

Moniteau....	C. Haldiman & Co. (Swiss).	Jamestown.	Pettis	E. N. & W. D. Norton.	Sedalia.
Do.....	C. Haldiman & Co. (4 Swiss ch. facts).	California.	Do.....	M. S. Elliott.....	Do.
			Do.....	C. P. Sheperd.....	Do.

Dairy companies in Missouri.

County.	Name.	Post-office.	County.	Name.	Post-office.
Jackson	Midland Dairy Co.	Kansas City.	St. Louis City	Union Dairy Co.	St. Louis.
Do.....	Kansas Creamery and Supply Co.	Do.	Do.....	Bonne Terre Dairy Co.	Do.
Do.....	Dickey Dairy Co.	Do.	Do.....	Grafemann Dairy Co.	Do.
Do.....	Mo. Dairy Ass'n.	Do.			
St. Louis City	St. Louis Dairy Co.	St. Louis.			

Leading farm butter dairies in Missouri.

County.	Name.	Post-office.	County.	Name.	Post-office.
Adair.....	John Patterson	Kirkville.	Marion	B. C. Settles	Palmyra.
Atchison	Dan Drago	Langdon.	Montgomery	A. W. Hathaway	High Hill.
Callaway	J. L. Erwin	Steedman.	Nodaway	J. W. Harman	Barnard.
Henry	Goodrich Bros.	Calhoun.	Pettis.....	W. H. H. McVey	Sedalia.
Do.....	H. T. Burris	Clinton.	Do.....	G. B. Lamm	Do.
Do.....	Thos. Day	Lewis Sta.	Do.....	S. R. Landis	Do.
Do.....	Armstrong Bros.	Clinton.	Do.....	H. Green	Do.
Do.....	Joseph Elliott.....	Windsor.	Do.....	N. K. Leiter	Do.
LaFayette	T. C. Sawyer	Lexington.	Do.....	A. Dow & Sons	Georgetown.
Livingston	Mart Brooks	Cavendish.	Schuyler.....	Wood O'Brien.....	Lancaster.
Do.....	J. Strong	Do.	St. Charles	Leo Hayden	St. Paul.
Do.....	C. K. Moser	Chillicothe.	Do.....	A. Woodhull	Foristell.
Do.....	J. W. McCune	Avalon.	Webster.....	A. S. Monett	Marshfield.
Marion	Col. W. H. Hatch	Hannibal.			

Creameries in Kansas—1896.

County.	Name.	Post-office.	County.	Name.	Post-office.
Anderson.....	Greeley	Greeley.	Dickinson	A. G. Eyth.....	Woodbine.
Do.....	J. N. Morris	Garnet.	Do.....	A. D. Blanchard	Herington.
Atchison	J. L. Fuller	Atchison.	Do.....	Hope Creamery Co.	Hope.
Do.....	S. A. Kepner	Effingham.	Do.....	Belle Springs Creamery Co.	Dillon.
Barton	Heizer Creamery Co.	Heizer.	Do.....	do.....	Belle Springs.
Do.....	Logan Township Creamery Co.	Cliffin.	Do.....	do.....	Holland.
Do.....	Ellinwood Creamery and Mfg. Co.	Elinwood.	Do.....	A. G. Eyth.....	Solomon.
Do.....	W. G. Merrill & Co.	Great Bend.	Do.....	do.....	Enterprise.
Bourbon	Fulton Creamery Co.	Fulton.	Do.....	Belle Springs Creamery Co.	Abilene.
Butler	Lewelling & Co.	Angusta.	Douglas	Douglas County Creamery Co.	Lawrence.
Do.....	D. N. Lambert	Elbing.	Do.....	Eudora Creamery Co.	Eudora.
Do.....	Towanda Creamery Co.	Towanda.	Do.....	Lone Star Creamery Co.	Bond.
Do.....	Sunflower State Creamery Co.	El Dorado.	Do.....	Big Springs Creamery Co.	Big Springs.
Do.....	C. C. Miller	Leon.	Do.....	J. G. Knox	Baldwin.
Do.....	Hesston Creamery ..	Whitewater.	Do.....	Crofoot Creamery ..	Wilson.
Cherokee	E. B. Davis	Columbus.	Do.....	Wellsville Creamery Co.	Wellsville.
Clay	Clay Center Creamery Co.	Clay Center.	Franklin	Richmond Creamery Co.	Richmond.
Do.....	Morganville Creamery Co.	Morganville.	Do.....	do.....	do.....
Do.....	Chapman Valley Creamery and Mfg. Co.	Oak Hill.	Geary (or Davis)	Oakwood Creamery Co.	Junction City.
Do.....	Belle Springs Creamery Co.	Longford.	Do.....	B. F. Small	Welcome.
Cloud	C. F. Armstrong.....	Clyde.	Do.....	R. H. Goodsell	Quinter.
Coffey	Waverly Creamery ..	Waverly.	Harper	Hesston Creamery Co.	Harper.
Cowley	J. P. Baden	Winfield.	Do.....	Burrton Creamery Co.	Burrton.
Crawford	D. H. Young	Girard.	Do.....	Hesston Creamery Co.	Hesston.
Do.....	Beulah Creamery Co.	Beulah.	Do.....	do.....	do.....
Dickinson	Belle Springs Creamery Co.	Talmage.	Do.....	do.....	Halstead.
Do.....	Manchester Creamery Co.	Manchester.	Do.....	Sedgwick Butter and Cheese Co.	Sedgwick.
Do.....	Geo. W. Hanna	Industry.	Do.....	Trousdale Creamery Co.	Trousdale.
Do.....	Oakwood Creamery Co.	Moonlight.	Do.....	Walton Creamery Co.	Walton.
Do.....	Chapman Creamery Co.	Chapman.	Jackson	B. F. Fisher	Soldier.

Creameries in Kansas—1896—Continued.

County.	Name.	Post-office.	County.	Name.	Post-office.
Jackson	G. R. Bowser	Circleville.	Morris	Gustavo Dieckel-	White City.
Do.	J. G. Knox & Son...	Hoyt.	Do.	man.	
Do.	H. R. Dutt	Birmingham.	Do.	Wilsey Creamery	Wilsey.
Do.	Holton Creamery	Holton.	Do.	Co.	
Do.	Co.		Ness	Ness City Cream-	Ness City.
Do.	W. B. Fees & Co...	Whiting.	Do.	ery Co.	
Jefferson	Winchester Cream-	Winchester.	Osage	Carbondale Cream-	Carbondale.
Do.	ery Co.		Do.	ery Co.	
Do.	Meriden Creamery	Meriden.	Do.	Lyndon Creamery	Lyndon.
Do.	Co.		Do.	Co.	
Do.	J. C. Evans & Son..	Valley Falls.	Do.	Overbrook Cream-	Overbrook.
Jewell	Burr Oak	Burr Oak.	Do.	ery Co.	
Do.	Goodwin Bros.....	Mankato.	Ottawa	T. N. Creveling...	Bennington.
Do.	C. L. Emery	Formoso.	Do.	Minneapolis Butter	Minneapolis.
Johnson	Morse Creamery Co	Morse.	Do.	and Cheese Co.	
Do.	Spring Hill Cream-	Spring Hill.	Reno	Parker & Upde-	Hutchinson.
Do.	ery Co.		Do.	graph.	
Do.	Edgerton Creamery	Edgerton.	Do.	Salt Creek Cream-	Partridge.
Do.	Co.		Do.	ery Co.	
Do.	Gardner Creamery	Gardner.	Do.	D. N. Gish & Bro..	Hutchinson.
Kingman	D. N. Gish & Bro..	Kingman.	Do.	Hesston Creamery	Butler.
Leavenworth ..	Baschor Creamery	Baschor.	Do.	Co.	
Do.	Co.		Do.	D. N. Gish & Bro..	Nickerson.
Do.	Crescent Hill	Reno.	Do.	Haven Creamery	Haven.
Do.	Creamery.		Do.	Co.	
Do.	G. W. Wilkerson...	Tonganoxie.	Do.	Arlington Cream-	Arlington.
Lincoln	Golden Belt Cream-	Beverly.	Do.	ery Co.	
Do.	ery Co.		Republic ...	Belleville Creamery	Belleville.
Linn	Eastern Kansas	Blue Mound.	Rice	Sterling Creamery.	Sterling.
Do.	Creamery Co.		Riley	A. L. Goble & Co..	Riley.
Lyon	P. S. Miller	Neosho Rap-	Do.	F. L. Erpalding...	Leonardville.
Do.	ids.		Do.	Hanna Produce Co.	Lasita.
Do.	Emporia Creamery	Emporia.	Rush	McCracken Cream-	McCracken.
Do.	Co.		Do.	ery Co.	
Marion	Ahler Bros.....	Marion Cen-	Russell	L. Banker & Co....	Russell.
Do.	ter.		Saline	Belle Springs	Gypsum City.
Do.	Hillsboro Creamery	Hillsboro.	Do.	Creamery Co.	
Do.	Co.		Do.	T. M. Kent, M'g'r..	Brookville.
Do.	Funk & Co.....	Durham.	Shawnee ...	J. A. Morrow	Richland.
Do.	A. L. Beltz	Ramona.	Sedgwick ...	C. A. Welsh	Maize.
Do.	Lincolnville Cream-	Lincolnville.	Do.	Lewelling & Co....	Wichita.
Do.	ery Co.		Sumner	Wellington Cream-	Wellington.
Marion	Hesston Creamery	Peabody.	Do.	ery	
Do.	Co.		Wabaunsee ...	F. & H. Stueve.....	Alma.
Marshall	Walker Bros.....	Marysville.	Washington ..	Haskell & Bosworth	Hanover.
McPherson ..	Brandt & Essley...	Canton.	Do.	Geisfield Bros	Palmer.
Do.	Brandt & Essley...	Moundridge.	Do.	H. Lindeman	Linn.
Mitchell	Jensen Bros.....	Beloit.	Wilson	Meadowbrook	Fredonia.
			Do.	Creamery.	

Cheese factories in Kansas.

County.	Name.	Post-office.	County.	Name.	Post-office.
Dickinson ...	Rhinehart Cheese	Rhinehart.	Shawnee ...	J. A. Morrow	Richland.
Do.	Co.		Do.	H. N. Pond	Topeka.
Ford	Spearville Cheese	Spearville.	Do.	Wm. A. Bolea.....	Valencia.
Do.	Factory.		Do.	Wm. Granville.....	Dover.
Gray (or	Cimarron Cheese	Cimarron.	Wabaunsee ...	T. A. Rutledge.....	Keene.
Foots).	Factory.				
Jefferson	Nortonville Cheese	Nortonville.			
Do.	Mfg. Co.				



BULLETIN No. 19.

**U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.**

THE INSPECTION OF MEATS

FOR

ANIMAL PARASITES.

- I. THE FLUKES AND TAPEWORMS OF CATTLE, SHEEP, AND SWINE,
WITH SPECIAL REFERENCE TO THE INSPECTION OF MEATS.**
By **CH. WARDELL STILES.**
- II. COMPENDIUM OF THE PARASITES, ARRANGED ACCORDING TO THEIR
HOSTS.**
By **ALBERT HASSALL.**
- III. BIBLIOGRAPHY OF THE MORE IMPORTANT WORKS CITED.**
By **ALBERT HASSALL.**
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Prepared under the direction of
Dr. D. E. SALMON,
CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

Issued February 8, 1898.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1898.



LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., October 4, 1897.

SIR: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 19 of this Bureau, under the general title "The inspection of meats for animal parasites," a report on "The flukes and tapeworms of cattle, sheep, and swine, with special reference to the inspection of meats," prepared under my direction by Dr. Ch. Wardell Stiles, Zoologist of the Bureau. Appended to the report, and as valuable adjuncts thereto, are a "Compendium of the parasites" and a "Bibliography," prepared by Albert Hassall, M. R. C. V. S., of the Zoological Laboratory. Although the report is intended primarily for the use of the meat inspectors of this Bureau, it will be found of general interest to all sanitarians, since it treats of the communicability of certain parasites from animals to man, and suggests the necessary methods of prevention and treatment therefor. The publication and distribution of the bulletin will serve a useful purpose in disseminating knowledge of the precautions that are required to eradicate certain of the most important parasites affecting domesticated animals in this country—parasites which are a menace to the public health. Its early publication is desirable, as there is no work in the English language covering the subjects of which it treats.

Respectfully,

D. E. SALMON,
Chief of Bureau.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
ZOOLOGICAL LABORATORY,
Washington, D. C., July 10, 1897.

SIR: I have the honor to submit herewith for publication a report covering "The flukes and tapeworms of cattle, sheep, and swine, with special reference to the inspection of meats," prepared by myself, and the corresponding "Compendium of the parasites" and "Bibliography," prepared by Dr. Albert Hassall.

This report is intended primarily for meat inspectors, and contains discussions of the various flukes and tapeworms which our Bureau inspectors are likely to meet with on the killing floors of the abattoirs. Technical zoological details have for the most part been omitted, the stress being placed upon the practical application of our zoological knowledge to questions of public hygiene.

The more important parasites for the American inspectors are: The Common Liver Fluke and the Large American Fluke, which are serious dangers to the live stock; Beef measles, Pork measles, and Hydatids, all of which bear an important relation to diseases in man.

I would direct especial attention to the Hydatids. Hydatid disease is at present comparatively rare in this country, and now is the time to attack it. By proper precautions at the abattoirs and slaughterhouses this dangerous parasite can be totally eradicated from the country. If these precautions are not carried out it will be only a question of time when this country will take its place with Germany and Australia in respect to the number of human lives sacrificed to a disease which has not yet gained much ground with us and can now be easily controlled.

The illustrations of this bulletin were prepared by Mr. Haines, artist of the Bureau.

Respectfully,

CH. WARDELL STILES,
Zoologist of Bureau of Animal Industry.

Dr. D. E. SALMON,
Chief of Bureau of Animal Industry.

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THE INSPECTION OF MEATS FOR ANIMAL PARASITES.

I. THE FLUKES AND TAPEWORMS OF CATTLE, SHEEP, AND SWINE, WITH SPECIAL REFERENCE TO THE INSPECTION OF MEATS.

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INTRODUCTION.

The object of the report.—The present report on “The flukes and tapeworms of cattle, sheep, and swine, with special reference to the inspection of meats,” is intended primarily for the use of meat inspectors, and an effort has been made to bring together in systematic order the more important facts relating to the flukes and tapeworms which inspectors are likely to find in the abattoirs and slaughterhouses. For several reasons it is important that meat inspectors should be well informed upon both the practical and the theoretical considerations of this subject:

First. Since certain parasites (*Cysticercus cellulosae* and *C. bovis*) are directly transmissible to man through the use of meat, a knowledge of these worms will enable inspectors to prevent the spread of their tapeworm stage among human beings by condemning the infested meat or subjecting it to processes which will render it harmless. The rigid system of meat inspection in Germany has resulted in an actual decrease in tapeworm disease (by *Taenia solium* and probably also by *T. saginata*) in man and in the frequency of *C. cellulosae* in the human eye.

Second. Condemnation and destruction of organs infested with certain other parasites (*Echinococcus*, *Coenurus*, *Cysticercus tenuicollis*) will prevent the spread of these parasites in their tapeworm stage to dogs, and by that means prevent the reinfection of man (by *Echinococcus*) and of domesticated animals (by *Echinococcus*, *Coenurus*, *Cysticercus tenuicollis*); in this case prevention of tapeworm disease in dogs, though of comparatively little importance so far as the dogs are concerned, becomes very important not only in public hygiene (in the prevention

of disease in man and animals), but also from an economic standpoint, preventing financial loss to stock raisers from disease and death in their herds and flocks caused by these worms. The destruction of livers heavily infested with flukes will also result indirectly in decreasing fluke disease in man and live stock.

Third. Certain animal parasites (*Cysticercus cellulosae*, *C. bovis*, *Echinococcus*, etc.) may under certain conditions bring about pathological appearances in the meat which may at first sight be mistaken for tuberculosis. It is hardly necessary to insist upon the importance of a differential diagnosis between tuberculosis and diseases caused by animal parasites.

It is thus seen that the meat inspector is destined to render an important public service in the prevention of parasitic diseases, not only in man, but among domesticated animals.

Secondarily, this report is intended for the stock raiser, and an attempt has been made in the text to give him such information regarding the various parasites discussed as will be useful in preventing the spread of parasitic diseases among his animals. The stock raiser, whether the owner of a large herd or of but one or two animals, should never lose sight of the fact that his stock is raised not only as a money investment for himself, but as food for his fellow-men. To allow the introduction of certain diseases among his animals means not only a financial loss to himself, but a loss of health or life to those who may use these animals for food. To prevent these diseases is to increase the value of his investment and to aid the health authorities in preventing disease among his neighbors and his neighbors' stock. The stock raiser's position is therefore based not only upon dollars and cents, but also upon the broader plane of ethics, and he who intentionally or unintentionally and persistently loses sight of the ethical side of his occupation must necessarily suffer from the financial standpoint. The unprincipled action of placing diseased live stock on the market, instances of which can be cited from all civilized countries, is indeed a very short-sighted policy, which will sooner or later tell upon the purse of him who descends to such action, as well as upon the health of the community. A person who aids in concealing a smallpox or diphtheria patient from the health authorities and thus jeopardizes the health of his friends and neighbors justly earns the contempt of his fellow-beings as well as the punishment provided by law in some places; and a person who knowingly places diseased live stock or diseased meat on the market and thus endangers the health of those who consume the meat is none the less worthy of contempt and punishment.

In the third instance, this report is intended for butchers who handle meat which has not been inspected, as is unfortunately the case in many places, particularly in smaller towns. The writer has personally seen many towns where the meat supply was drawn almost entirely from local slaughterhouses, in which there was no inspection. Fre-

quently the butchers raised their own stock, or a portion of it, on the grounds of the slaughterhouses and under unhygienic conditions, which were not only most favorable to the spread of disease, but which must necessarily have resulted in the spread of infection among the animals raised upon the premises and in the neighborhood; especially in cases where the slaughterhouse was located on the banks of a creek or river.

In writing a report for the information of these three classes of persons, the author is well aware that technical language is not desired by the stock raiser and the butcher; a considerable amount of technical detail is, however, necessary in treating this subject in a manner which will be exact and complete enough for the expert inspector, who must view the questions from different standpoints. These technical details consist chiefly (1) of the classification and analytical keys to the various worms, necessary in order to properly determine the parasites found; (2) of detailed synonymy of each form, necessary because so many of the parasites are described in various works under different names; (3) details in regard to the life history of the worms, necessary in order to establish the proper methods of prevention; and, (4) details in the pathological appearances of diseased organs, necessary in order to differentiate between diseases which may bear a close resemblance to one another.

This technical discussion, necessary as it is to the expert inspector, has been forced to the background as much as possible by placing it in small type or in footnotes, and any, except sanitary officers and zoologists, who read this bulletin will do well to rely chiefly upon the discussion in large type.

Scientific nomenclature and synonymy.—One of the greatest aids in scientific work, giving exactness to statements and rendering the names of animals and plants international, is the use of Latin names for all plants and animals. These names should be given according to certain regulations agreed upon by workers in science, but owing to the disregard of these rules by some authors, many of the parasites discussed have received numerous technical names. In this paper the writer has endeavored to follow the international rules in selecting the technical name used for each parasite, and this name alone should be quoted in referring to the worms. The lists of synonyms are intended only as tables of reference, in order to trace the parasites as described by different authors.

Authorities consulted.—The majority of the parasites mentioned in the report have been known for many years and much has already been published upon them. In writing the report, therefore, I have not only drawn from my own personal studies, but have not hesitated to use the entire literature at my disposal. A list of the chief works consulted is given on pages 145-150, and of these I have used with special freedom Zürn (1882), Blanchard (1885-95), Neumann (1892), Railliet (1893), Oster-tag (1895), and my own papers.

GENERAL METHODS FOR THE PREVENTION OF PARASITIC DISEASES.

"A well-regulated system of slaughterhouses is as necessary to public health as is a well-regulated system of schools to public education."

Under the subject of prevention there will here be considered chiefly those rules which apply to the parasites discussed in this paper. The methods of prevention naturally fall under several heads:

(1) *Segregation of slaughterhouses.*¹—The first and most important step to be taken in order to prevent the spread of parasitic diseases is to segregate the slaughterhouses. In many places, especially in the West, we find two, three, four, or even five small slaughterhouses on the outskirts of a town of 300 to 2,500 inhabitants. These slaughtering places are scattered north, east, south, and west of the town; as they are often outside of the corporation limits, they do not come under the direct control of the local board of health; few, if any, of the State boards pay any attention to them, and as a result the meat supply is often without sanitary supervision.

The general rule may be laid down that every slaughterhouse is a center of infection for the surrounding neighborhood, not only of diseases caused by animal parasites, but also of other diseases, such as hog cholera, swine plague, tuberculosis, etc. The first step to be taken, therefore, is to reduce the number of localities from which infection may spread, and there is evidently only one way to do this, namely, to compel all the butchers of a town to do all of their killing at the same slaughterhouse. If the slaughtering is all done at one place, it is comparatively easy to control the class of animals used; but when numerous slaughterhouses exist, it is practically impossible to supervise the premises.

In many European cities and towns the slaughterhouse is built either at municipal expense or by a stock company, and stalls are let to the butchers for killing purposes. This plan has been found very satisfactory.

The places of slaughtering should be built of some more durable material, as brick, rather than wood; the less wood used the easier it is to keep the place clean. Even the floors should, if possible, be of brick, stone, or asphalt.

(2) *Sanitary supervision of slaughterhouses.*—There should be a competent veterinary inspector appointed as director of every slaughterhouse, with assistants if necessary. It should be the duty of the director and his assistants to see that the stalls and grounds are kept in proper sanitary condition, and that the offal is properly disposed of. In small towns, where there is not enough offal to pay for preparing it as fertilizer, there seems to be no valid sanitary objection to feeding the offal of healthy cattle and sheep to hogs; but offal of hogs should under no circumstances be fed to other hogs, unless it is first thoroughly cooked.

¹ Cf. Stiles, 1897. The Country Slaughterhouse as a Factor in the Spread of Disease. (Yearbook of the U. S. Department of Agriculture for 1896, pp. 155-166.)

(3) *Meat inspection*.—There should be a regular inspection, by a competent veterinarian, of all meats before they are allowed to leave the slaughterhouse.

(4) *Dogs and rats*.—Dogs should be excluded from slaughterhouses and meat shops, and all stray and ownerless dogs should be killed. This will prevent the spread of a number of dangerous parasites. Rats are common factors in spreading diseases from slaughterhouses, although they do not come into consideration in connection with any of the parasites discussed in this report.

(5) *The raising of hogs and other animals at slaughterhouses* is a custom which can not be too severely condemned, and the farmer who grants to a butcher the privilege of slaughtering on his farm in exchange for the use of the offal as feed simply bids for disease.

(6) *Deserted premises*.—In the segregation of slaughterhouses, which must come sooner or later, care should be taken to properly dispose of the houses which are deserted; an attempt should be made to kill the rats on the deserted premises, in order to prevent their spreading disease by wandering to neighboring farms, etc.

(7) *Domesticated animals* must not be allowed access to human excreta or to water supply contaminated by drainage from privies, vaults, etc.

TREATMENT.

The treatment of the verminous diseases of cattle, sheep, and swine, discussed in this report, may be summed up in two rules:

(1) The treatment for the larval tapeworms and the liver flukes must be preventive, as no medicinal treatment known is satisfactory.

(2) The treatment for the adult tapeworms and the intestinal flukes should be medicinal, as this is effective, and the life history of most of these worms still being problematical, we have no satisfactory data upon which to base preventive measures.

(For details regarding prevention and treatment,¹ see these captions under each parasite.)

THE DISPOSITION OF CONDEMNED MEATS.

The proposition that diseased meats which are dangerous as articles of food should not be allowed on the market is one which will receive universal support from all sanitarians and also from the thinking pub-

¹ In connection with the subject of treatment, I would call the attention of veterinarians to the necessity of not forgetting that a prescription written in one country does not mean the same in all countries. In dealing with pounds, ounces, and grains the apothecaries' weight, United States, agrees with the imperial standard troy, but many of the articles used in dosing large herds are purchased at avoirdupois weight. The apothecaries' United States, and the imperial liquid measures do not agree, a point which should be borne in mind in utilizing English formulæ in this country. Have not many accidents occurred because English formulæ were taken, and the fact overlooked that the English gallon is one-fifth larger than the United States gallon? Hutcheon's wireworm treatment (pp. 133-135), if adopted in this country without making due allowance for the difference in the size of the gallon, would probably result in heavy losses to the sheep owner.

lic. The question, however, arises as to the classes of diseased meats and the stages in these diseases that justify their condemnation or that justify their sale and the method of their disposal if condemned. It is not the purpose of this report to discuss the general aspect of these questions, but only to discuss them so far as the diseases caused by animal parasites are concerned.

In some foreign cities regulations exist, or have existed, compelling the burial or burning of meats affected with certain parasitic diseases. To such extreme regulations we are opposed for several reasons. In the first place, such destruction by burial or burning is in itself an expense. It also results in a total and unnecessary loss of the carcass. Again, the burial of a diseased carcass, unless buried in quicklime or other destructive material, does not meet either the practical or the theoretical requirements of destruction of diseased material. Take the disease trichinosis, for instance. In some places the carcasses of trichinous hogs have been buried by order of the sanitary officials. After this has been done, the owners of the carcass have disinterred the hog and it has been used for food!¹ Even had these men not disinterred the body and fed it to their friends and customers, the grave would have been accessible to rodents, such as rats, field mice, etc., which would be likely to feed upon the carcass, and thus become infected with the disease, resulting in a possible (theoretical!) ultimate transmission of the disease to other hogs. Finally, the writer is opposed to this method of destruction (?) on the ground that diseased or partially diseased carcasses can be utilized under certain conditions and restrictions, so that the owner will not lose the entire amount of his investment.

Three methods in particular are open, the method selected being dependent (1) upon the nature, extent, or stage of the disease, and (2) the facilities at hand. These methods are: (1) Utilization as fertilizer; (2) rendering the meats harmless by cold storage, cooking, or preserving, and then placing them upon the market; (3) selling the meats under a declaration of their character.

In determining the extent or stage of the disease and its relation to the method of disposition of the carcass, the opinion of the meat inspector must, of course, be based upon certain general principles and must naturally be final.

Utilization as fertilizer.—There is no parasitic disease known which will withstand the degree of heat used at the large abattoirs in the preparation of fertilizers. "Tanking for fertilizers" is therefore an absolutely safe method for the disposition of condemned meats, no matter how serious the infection is or to what extent the disease has progressed.

In connection with some parasitic diseases, however, a question arises as to the necessity of condemning to the tank certain diseased cou-

¹ This has happened a number of times in Germany, one case being reported within less than a year! (See *Zeitschr. f. Fleisch- und Milchhygiene*, 1897, VII, (5), p. 104.)

ditions. A case of generalized cestode-tuberculosis (*Cysticercus bovis*) should undoubtedly be "tanked," but in a very light infection the question takes a different aspect, namely: Can not the diseased portion be cut out and the rest of the carcass be placed on the block? To allow such meat on the market, leaving the consumer to suppose that he is purchasing a first-class article, is evidently an injustice to the buyer, for it is by no means certain that all of the parasites have been detected and removed. To condemn a light infection of this disease is, on the contrary, an injustice to the dealer, for there are methods by which the remaining parasites, if any, may be rendered harmless, and in this case the dealer could be saved a part of his loss. To judge between those cases in which the carcass is absolutely unfit for food, and therefore to be condemned, and those cases in which the carcass may be treated according to methods which will destroy the remaining but undiscovered parasites, thus rendering the meat fit for food, is a point upon which the expert meat inspector must decide.

To follow up the example cited, let us examine the effects of cold storage, cooking, and salting. It is evident that the method chosen must depend upon the facilities at hand. At a large abattoir any of these methods might be followed, but at a small country slaughterhouse the choice would be restricted.

Cold storage.—Experiment shows that the parasite under discussion (*Cysticercus bovis*) dies about two to three weeks after the death of its host. Three weeks of cold storage would therefore render a light infection of this kind absolutely harmless, and the meat could safely be placed on the block. With the disease known as pork measles the parasites live for a month or more, so that more care would be necessary in dealing with it.

Cooking.—Many of the abattoirs voluntarily tank for canning certain meats of inferior quality. The heat to which these meats are subjected is not so great as that used in tanking for fertilizers, but as *Cysticercus bovis* can not survive a temperature of 140° F. (see p. 81) for five minutes, and as the meats tanked for canning are thoroughly cooked, it may safely be asserted that a light case of "beef measles" would be rendered perfectly harmless by the cooking preparatory to canning.

The same applies to cases of trichinosis. The parasite of this disease can not withstand a heat of 70° C. (=158° F.), so that if trichinous pork is cooked until the entire piece has reached this temperature and assumed a light-gray color, the disease is rendered nontransmissible to man.

Salting.—The parasite of "beef measles" is killed in twenty-four hours by the action of salt solution, and we have found no case where the parasite of trichinosis has been able to withstand four months in the "pickling vats." In both of these cases it must be remembered that it takes some time for the salt to thoroughly permeate the tissue. It

would accordingly not be safe to assume that in a piece of measly beef which had been placed in brine for twenty-four hours the parasites had been killed. The length of time necessary to guaranty the result is, of course, dependent upon the size of the piece of meat.

Selling infected meats under declaration.—While the large abattoirs have means at their command by which cases of light infection may be rendered noninfectious, the smaller slaughterhouses are at more of a disadvantage in this respect. Cooking and salting would be possible for some—perhaps all of them—while cold storage would often be out of the question.

In this connection, it will be interesting to study for a moment a system which is quite extended in certain parts of Europe. Reference is made to the German "*Freibank*" or "*Finnenbank*." Under this system certain meats of inferior quality are allowed to be placed on the market under given conditions. One of these conditions is that they must be sold in a specified meat stall or counter, known as the "*Freibank*" or "*Finnenbank*," where the true nature of the meat must be made known to the purchaser. Naturally, such meats are sold at a lower price than the meats offered in open market, thus enabling many of the poorer classes to purchase meat who can not afford to pay the regular prices. Meats which are absolutely dangerous from a sanitary standpoint are, of course, excluded from these special meat counters, and in some instances the law requires that even these meats of inferior quality, which are harmful in some cases, though not dangerous, must be rendered harmless before being sold.

In the United States inspected meats are, generally speaking, either passed and allowed to go upon the open market or condemned and thus excluded from the market. The German system of the "*Freibank*" practically results in dividing the meats into three¹ classes, namely, first, meats which may be sold in open market—good or first-class meats

¹ Strictly speaking, the Imperial German law of May 14, 1879, divides meats into five classes, as follows:

"1. Good or first-class wares which may be placed upon the open market without restrictions. This corresponds to the '*bankwürdiges Fleisch*' of the South German meat inspection regulations.

"2. Meat which may be placed upon the market under declaration and sold as 'spoiled (or waste) goods in the sense of the food laws.' Other disposition of this meat (as use in one's own family or presentation to other persons), is not prevented by law. This meat is called '*nichtbankwürdiges Fleisch*' in the older regulations.

"3. Meat which is unconditionally dangerous or injurious to health, the use of which, under any condition, as food for man, even use in one's own family, presentation to other people, or permitting it to be taken away, etc., is forbidden by law. This meat must be disposed of in such a way as to render it harmless.

"4. Meat which is injurious to health under certain conditions, but which can be rendered harmless by proper manipulation, such as cooking, sterilizing, pickling, etc. After the meat has been rendered harmless it may be placed on the market as

("gute oder tadellose Ware," of North Germany, "bankwürdiges Fleisch," of South Germany, also called "bankmässig" or "ladenrein"); a second class of meats which may be sold only under declaration of their true character, in many cases only after having been cooked or salted under official supervision ("nichtbankwürdig," "nichtbankmässig," "nichtladenrein"); a third class of meats which are unconditionally condemned, and therefore excluded from the market.

History of the "Freibank."—The system of the German "Freibank" and compulsory declaration of the condition of inferior meats is very old. The municipal laws of Augsburg in 1276 prescribed that inferior meat should not be sold without giving notice as to its quality. In 1404 the municipal laws of Wimpfen provided that the "Freibank" (from the German "frei," free, here in the sense of unconnected or separated, and "Bank," a counter or stall) should be situated three paces away from the regular counters. The "Freibank" (free stall) was, therefore, one which was free or separate from the regular counters. The term "Finnenbank" is sometimes used for these special meat stalls because the measly meat ("finniges Fleisch") especially is sold at these places. This system of "Freibank" has been extended to most of the slaughterhouses of Germany, and is rapidly extending in France, Belgium, and Italy.

The economic importance of the system is seen from the following statistics taken from Ostertag:

In the Kingdom of Saxony in 1892, 0.25 per cent of the animals

spoiled (or waste) meat, in the sense of the food law. In regard to selling this kind of meat raw compare the legal decisions:

"An explicit statement by the seller that the meat, which is rendered harmless by cooking, is to be eaten only when cooked protects the merchant from penalty." (Urt. IV, v. II, 7, 1884.)

"A simple statement regarding the unwholesome condition of the meat on the part of the merchant to the purchaser does not, however, render the former free from penalty, for the danger to the communal interests of the act is not thereby obviated." (Urt., v. 15, 1 and 29, 9, 1885.)

"5. Finally, there should be recognized meat which is spoiled beyond use [literally, spoiled in high degree], i. e., meats which, though not unwholesome, have lost their value as food for man because of extensive changes in the tissue (for example, watery meat, meat and organs which are heavily infested with parasites, etc.). Such meats are to be judged as 'unfit for food,' and can be looked upon as 'spoiled' in the sense of sec. 367 of the penal code, and offering for sale and selling such meats are plainly forbidden by this paragraph. Their use in the household of the owner can not, however, be forbidden on grounds of the Imperial regulations. In order to prevent underhand traffic with such meat, it is provided that meat which is spoiled beyond use is to be entirely excluded from the market, except in such cases as portions of the same, such as the fat in heavily infected cases of pork measles, can be used for food.

"In meat wares we further distinguish imitations [*nachgemachte*] (meats which are treated in such a way as to appear different from what they really are, Urt. I, v. 15, 5, 1882), and adulterations [*verfälschte*] (meats which do not possess those qualities which they are supposed to possess in reliable traffic).

"I will call attention to the fact that the expert must use the word 'spoiled' [*verdorben*] only in the legal sense and not in the sense of decomposed meat, for decomposing [*faulende*] meat is injurious to health."—OSTERTAG, 1895, pp. 100, 101, et al.

slaughtered for food were unconditionally condemned, while 0.42 per cent of the animals slaughtered were sold at the "*Freibank*."

In Leipzig during 1891 the meat of 604 cattle, 89 calves, 28 sheep, 983 hogs, and 104 pieces, representing a total weight of 271,608 kilograms (about 543,216 pounds), was used by the "*Freibank*."

The average receipts per pound for the first quality meats and for the meat sold at the "*Freibank*" after deducting fees were as follows:

First quality.	Price.
Beef.....	57.6 pfennige, about \$0.144
Veal.....	55.5 pfennige, about .138½
Mutton.....	58.8 pfennige, about .147
Pork.....	61.0 pfennige, about .152½
Freibank.	Price.
Beef.....	53.8 pfennige, about \$0.134½
Veal.....	44.2 pfennige, about .110½
Mutton.....	54.5 pfennige, about .136½
Pork.....	57.4 pfennige, about .143½

Ostertag (1896) has recently published a detailed compilation giving the data concerning the sale of measly beef in 38 cities in Germany. At first there was great prejudice against the meat, so that in some cases the price fell to 2½ cents per pound; but as this prejudice wore off the price went up 6, 8, and 10 cents per pound. In some places the demand for this cheaper meat is greater than the supply.

Objections to the "*Freibank*" have been raised by some parties, but we are unable to see wherein this system is unfair either to the dealer or to the purchaser, for no one is obliged to buy this meat who does not wish to do so, while anyone who wishes a cheaper class of meat can purchase it at the "*Freibank*" with the full knowledge of the condition of the meat he is buying. It is perfectly safe to use the meat when thoroughly cooked, and the dealer is able to economize in his business. We take the decided stand, however, that it is far better to subject all of these meats to thorough cooking or other methods of safeguarding before they are placed upon the market.

PARASITIC WORMS OF CATTLE, SHEEP, AND SWINE.

The term "cattle" in this report is used in the American sense of the word, i. e., for the species known zoologically as *Bos taurus*, the only bovine animal at present slaughtered in this country. Other animals also are known under the terms cattle, bulls, etc., in some countries, and a few parasites found in these animals are mentioned briefly in this report. These parasites are cited because the same species, or at least the same genera, are likely to infest *Bos taurus* sooner or later.

The term "sheep," as used here, refers to the only species of sheep slaughtered in the United States, i. e., *Ovis aries*.

The terms "hog," "pig," and "swine" refer to the only species of domesticated swine found in this country, i. e., *Sus scrofa domestica*.

The parasitic worms found in cattle, sheep, and hogs belong to two different zoological groups, known as Flat worms (*Plathelminthes*) and

Round worms (*Nemathelminthes*). The Flat worms alone are discussed in this report.

FLAT WORMS (Class *Plathelminthes*).

The Flat worms include at present five orders, only two of which, namely, the flukes (*Trematoda*) and the tapeworms (*Cestoda*), are discussed in this report.

FLUKES, OR TREMATODES.—The flukes found in cattle, sheep, and swine vary in size from a few lines to 4 inches in length and from one or more lines to an inch or more in breadth. They are found in the liver, lungs, intestine, and body cavity, and occasionally in other parts of the body. None of the species found in cattle, sheep, or swine are directly transmissible from these animals to man, although three of the species occasionally infest man. At least two of the species render the organs in which they occur unfit for food when present in numbers; they also injure the animals to a greater or less degree, although the extent of injury in cattle has possibly been overestimated; one form is particularly injurious to sheep.

TAPEWORMS, OR CESTODES.—Cestodes occur as larval forms (*bladder worms*) or as adult forms (*tapeworms, strobilae*).

Larval tapeworms.—The larvæ, or bladder worms (*Cysticercus, Coenurus, Echinococcus*), are found in the liver, lungs, brain, muscles, or other organs except the intestinal tract, and do not reach maturity until they are transmitted to meat-eating animals. The most important bladder worms considered in this report are: (1) The *Beef-measle Bladder Worm*, and (2) the *Pork-measle Bladder Worm*, both of which develop into tapeworms in man; (3) the *Gid Bladder Worm*, which causes gid, or turn-sick, in sheep; and, (4) the *Hydatid*, which causes hydatid disease in man and various domesticated and wild animals. When eaten by dogs the two latter bladder worms develop into Adult tapeworms.

Adult tapeworms.—Several different species are found in the intestine of cattle and sheep. They injure their hosts, but are not transmissible to man in any stage of their development.

The following key will aid the reader in determining the various flukes and tapeworms discussed in this report. A certain amount of technical knowledge is valuable in the use of this key, which is based upon zoological characters. Some liberty has, however, been taken with the anatomical characters in order to make the key as simple as possible; and it is believed that most, if not all, of the forms mentioned can be more or less definitely determined by comparing the key, especially the *habitat* given for each form, with the figures of the parasites, even if one is unable to follow the more technical statements.

KEY TO THE FLUKES AND TAPEWORMS OF CATTLE, SHEEP, AND SWINE.

[For the species thus far positively known to have been found in North America, follow Roman type. As the characters given are confined to the forms discussed in this report, this key should not be relied upon to classify the parasites of other animals.]

- (1) Parasitic in the liver, lungs, pancreas, veins, abdominal cavity, or intestine of cattle, sheep, and swine, more rarely encysted in muscles of swine. Unsegmented Flat worms; intestinal tube present; anus absent; mouth with one sucker *Flukes, 2.*

Parasitic in the intestine, more rarely in bile ducts, as adult segmented worms; or in the liver, lungs, muscles, etc., as unsegmented bladder worms. Intestinal tube absent; head with four suckers..... *Tapeworms*, 14.

FLUKES.

(Trematoda.)

- (2) Parasitic in liver, lungs, pancreas, veins, or abdominal cavity of cattle, sheep or swine, rarely encysted in muscles of swine. Ventral sucker (acetabulum) on anterior half of body *Fasciolidae*, 3.
Parasitic in intestinal tract or gall ducts of sheep, cattle, zebu, gayal, or buffalo. Ventral sucker (acetabulum) at posterior extremity *Amphistomidae*, 9

Fasciolidae.

- (3) Parasitic in liver, lungs, pancreas, or abdominal cavity of cattle, sheep, or swine, more rarely encysted in muscles of swine. Hermaphrodites.... *Fasciolinae*, 4.
Parasitic in the blood of cattle and sheep; eggs found forming egg tumors in genito-urinary tract or colon. Sexes separate *Schistosominae*, 8.

Fasciolinae.

- (4) Parasitic in liver, lungs, pancreas, or abdominal cavity. Mature flukes, or forms in which the genital organs are developed to an extent which permits of a determination of the genus. Acetabulum sessile; genital pore between oral sucker and acetabulum; oral sucker unarmed..... 5.

Encysted in muscles of swine, very rare. Must not be mistaken for trichinae. Immature fluke, in which the organs do not permit of a determination of the genus. Body (fig. 1) 0.5 mm. long, elliptical, grayish, transparent; oral sucker terminal; ventral sucker near the middle of the body; pharynx followed by a short oesophagus and two simple intestinal caeca, which extend slightly beyond the middle of the body; in front of acetabulum are four large unicellular glands with rather long ducts, extending to oral sucker; three primordial genital glands in distal half of body; terminal excretory canal median, branching immediately distal of testicles.

The Muscle Fluke of Swine (*Agamodistomum suis*), p. 28.

- (5) Parasitic in liver, lungs, rarely abdominal cavity of cattle, sheep, or swine. Body large, shaped like a flat fish, dark colored; intestinal caeca, testicles and ovary profusely branched; freshly laid egg does not contain embryo.

Fascioles (Fasciola), 6.

Parasitic in liver or pancreas of cattle, sheep, or swine. Body smaller; intestinal caeca very simple, long, tubular, extending beyond acetabulum to posterior portion of body; oesophagus comparatively short; genital pore at bifurcation of intestine; testicles two, may be slightly lobate, near acetabulum; ovary posterior of and smaller than testicle, but anterior of transverse vitello-duct; ovary and testicles anterior of mass of uterine coils which extend to posterior end of the body.

Dicrocoele (Dicrocoelium), 7.

Fascioles (Fasciola).

- (6) Parasitic in liver or lungs of cattle. Body (figs. 28-30) flesh-colored, very large and thick, 20 to 100 mm. long by 11 to 26 mm. broad; anterior conical portion not very distinct from posterior portion; posterior extremity bluntly rounded; vitellogene glands situated ventrally of intestine; oesophagus generally one and one-half times as long as pharynx; eggs 109 to 168 μ by 75 to 96 μ .

The Large American Fluke (*F. magna*), p. 49.

Parasitic in liver or lungs of cattle, sheep, hogs, etc. Body (figs. 2 and 3) 18 to 51 mm. long (occasionally longer) by 4 to 13 mm. broad; anterior conical portion generally very distinctly bounded from posterior portion; posterior extremity bluntly pointed; vitellogene glands both dorsal and ventral of intestine; oesophagus rarely one and one-half times as long as the pharynx; egg 105 to 145 μ by 63 to 90 μ The Common Liver Fluke (*F. hepatica*), p. 29.

Parasitic in liver of Senegal cattle. Body (figs. 23 and 24) 26 to 33 mm. long by 6 to 8 mm. broad, flat, linguiform, sides of posterior portion nearly parallel for some distance but tapering toward posterior extremity; ventral sucker large and prominent; egg 143 to 151 μ by 82 to 88 μ .

The Narrow Liver Fluke (*F. hepatica angusta*), p. 48.

Parasitic in the Indian buffalo (Bos bubalis) and cattle (Bos taurus). Body (figs. 25 and 26) 25 to 31 mm. long by 6 to 8 mm. broad; sides of body nearly parallel for some distance; posterior extremity somewhat rounded.

The Egyptian Liver Fluke (*F. hepatica aegyptiaca*), p. 48.

Parasitic in the liver of giraffes and cattle (?). Body (fig. 27) 75 mm. long by 3 to 12 mm. broad, flat, oblong, lancolate; anterior extremity cylindrical, attenuate; posterior extremity obtuse; sides nearly parallel for greater part of length; oral sucker 1.12 mm. in diameter, ventral sucker somewhat larger; oesophagus extends nearly to acetabulum; 8 to 10 lateral branches to each intestinal caecum; other organs agree with F. hepatica..... The Giant Fluke (F. gigantica), p. 49.

Dicrocoele (Dicrocoelium).

(7) *Parasitic in liver of cattle, sheep, and swine. Body (figs. 36 and 37) lancet form, 4 to 10 mm. long by 1 to 2.5 mm. broad; anterior end much more attenuate than posterior end; semitransparent, spotted brown by eggs; cuticle without spines; oral sucker 0.5 mm. in diameter, subterminal; ventral sucker 0.6 mm. in diameter, one-fifth the length of body back of mouth; mouth followed by an oesophagus which, about halfway between oral sucker and acetabulum, immediately in front of cirrus pouch, branches into two simple intestinal caeca; the latter extend one each side to about the posterior quarter of the body; cirrus pouch present; cirrus long, filiform, straight; testicles lobed, one posterior to the other, and situated immediately posterior of acetabulum; uterus sinuous, very long, extending backward beyond the end of the intestine to posterior portion of body, then running forward in loops to genital pore, and rendered prominent by presence of brown eggs; vitellogene glands in marginal portion of middle third of body; eggs (fig. 38) 40 to 45 μ by 30 μ , containing embryo at time of oripont..... The Lancet Fluke (D. lanceatum), p. 55.*

Parasitic in pancreas of "cattle," Indian buffalo, and sheep, in Asia. Body (fig. 40) somewhat similar to the common fluke but proportionally broader and more pointed at distal extremity; 8 to 15 mm. long by 5 mm. broad; blood red in color; cuticle without spines; oral sucker subterminal; ventral sucker slightly larger than oral sucker, one-third the length of the body back of the mouth; pharynx, oesophagus, and intestines about the same as in D. lanceatum; cirrus-pouch pyriform; testicles irregularly lobed, in lateral portion of median field, on same transverse plane, near acetabulum; uterus of similar type to that of D. lanceatum; vitellogene glands only about one-fifth as long as body, situated in marginal portion of middle third; eggs ovoid, thick shelled, 44 μ to 49 μ by 33 μ to 30 μ .

The Pancreatic Fluke (*D. pancreaticum*), p. 57.

Blood Flukes (Family Schistosominae; Genus Schistosoma).

[Acetabulum penduculate; intestinal caeca unite or anastomose distal of acetabulum; male shorter, thicker, and broader than female, the margins curling ventrally to form canal for filiform female; testicular complex consists of a double series of four or more sacular bodies.]

(8) *Parasitic (fig. 41) in blood of man and cattle (?). Male 4 to 14 mm. long by 1 mm. broad; female attains 13 to 20 mm. long by 0.28 mm. broad by 0.21 mm. thick; eggs ovoid to fusiform 120 to 197 μ long by 40 to 73 μ broad.*

The Human Blood Fluke (*S. haematobium*), p. 58.

Parasitic (fig. 45) in blood of cattle. Body thicker than the Human Blood Flukes; the dorsal surface of the inner fold of the male is provided with a longitudinal groove (fig. 46) into which the end of the outer fold extends; eggs fusiform, 120 to 180 μ by 40 to 50 μ The Bovine Blood Fluke (S. bovis), p. 60.

Amphistomes (Amphistomidae).

- (9) Parasitic in intestinal tract or gall ducts of sheep, cattle, zebu, and gayal. Pharynx without lateral sacs 10.
Parasitic in intestinal tract of zebu and gayal. Pharynx with two lateral sacs; the greater part of the ventral surface of posterior portion of body is covered with numerous papillae *Homalogaster*, 13.
- (10) Parasitic in intestinal tract or gall ducts of sheep, cattle, and zebu. Ventral pouch very small or absent True *Amphistomes (Amphistoma)*, 11.
Parasitic in intestinal tract of cattle, zebu, gayal, and Indian buffalo. Ventral pouch large, extending to posterior portion of body.
 Pouched Amphistomes (Gastrothylax), 12.

True Amphistomes (Amphistoma).

- (11) Parasitic in rumen of sheep and cattle. Body (figs. 49 and 50) 4 to 13 mm. long by 1 to 3 mm. broad; conical, pinkish white. The Conical Fluke (*A. cervi*), p. 64.
Parasitic in gall bladder and hepatic ducts of zebu. Body lanceolate, 8 to 10 mm. long by 3 to 4 mm. broad, rather similar to the Conical Fluke, but somewhat flattened dorso-ventrally *A. explanatum*, p. 67.
Parasitic in stomach of zebu. Body (fig. 56) somewhat similar to A. cervi, but more oval, and somewhat flattened dorso-ventrally; about 11 mm. long by 6.6 mm. broad.
 A. bothriophorum, p. 67.

Pouched Amphistomes (Gastrothylax).

- (12) Parasitic in stomach of zebu and cattle. Body (figs. 57-62) reddish brown to grayish green, 9 to 15 mm. long by 4 to 5 mm. broad *G. crumenifer*, p. 67.
Parasitic in stomach of gayal. Body (fig. 63) pyriform, 10 mm. long by 5 mm. broad at posterior extremity *G. Cobboldii*, p. 67.
Parasitic in stomach of gayal and zebu. Body attains (fig. 64) 20 mm. long by 4 mm. broad; intestine only half as long as body *G. elongatum*, p. 67.
Parasitic in stomach of Indian buffalo. Body (figs. 65 and 66) deep red, cylindrical to conical, attains 7 to 10 mm. long by 2 to 2.5 mm. broad *G. gregarius*, p. 67.

Homalogaster.

- (13) Parasitic in caecum of gayal. Body (fig. 67) lanceolate; testicles small.
 H. paloniae, p. 67.
Parasitic in caecum of "cattle" (= (?) zebu). Body — mm. long; oral sucker with digitate papillae; testicles lateral and divided into two equal lobes with irregular contours, so that there appear to be four testicular masses *H. Poirieri*, p. 67.

TAPEWORMS.

(Cestoda.)

- (14) Larval tapeworms or bladder worms (figs. 68, 76, 84, 97, and 105) parasitic in muscles, liver, lungs, etc., but not in lumen of intestinal tract; the head, which is generally provided with hooks, lies inside the cyst; body unsegmented, generally surrounded by a cyst of connective tissue; no genital organs developed; these forms become adult in man and carnivorous animals, and are of great importance from the standpoint of meat inspection... *Taeniinae*, 15.
 Adult tapeworms (fig. 111), found in the intestine of cattle, sheep, and swine (?), or in gall ducts of sheep *Anoplocephalinae*, 18.

Bladder Worms, or Larval Tapeworms (Hard-shelled Tapeworms, Subfamily Taeniinae; Genus Taenia).

- (15) Parasitic in muscles, abdominal cavity, lungs, and liver. One head in each cyst Bladder Worms (*Cysticercus*), 16.
Parasitic in any organ of body except intestine, most frequent in liver, lungs, and brain. Numerous heads may be present 17.

Bladder Worms (Cysticercus).

- (16) Parasitic in cattle; found in the muscles, especially those of mastication, more rarely in lungs or liver. Body (fig. 68) spherical to elliptical, 2.5 to 10 mm. long by 3 mm. broad; whitish to gray, with a small yellowish spot due to the invaginated head; no hooks present; the bladder contains but little liquid. Transmissible to man..... Beef Measle Bladder Worm (*C. bovis*), p. 71.
- Parasitic in swine; found in the muscles. Body (figs. 75 and 76) ellipsoid, 6 to 10 mm. long by 5 to 10 mm. broad, with a white spot corresponding to the invaginated head; head armed with a double row of 24 to 32 hooks of two different sizes (see description of adult, p. 84); the bladder contains but little liquid. Transmissible to man..... Pork Measle Bladder Worm (*C. cellulosae*), p. 89.
- Parasitic in cattle, sheep, and swine; young stages in the liver, older stages found hanging into the body cavities, attached to omentum, etc. Bladder (figs. 84, 91, and 92) large, varying from size of a pea to that of a man's fist, occasionally attaining 160 mm. by 60 to 70 mm.; neck long; invaginated head armed with a double row of 28 to 44 (generally 36 to 38) hooks, of two sizes (see description of adult, p. 101); the bladder contains considerable liquid. Transmissible to dogs, but not to man.

The Thin Necked Bladder Worm (*C. tenuicollis*), p. 96.

Coenurus and Echinococcus.

- (17) Parasitic in nervous system, especially the brain, of sheep and calves. Bladder (figs. 94 and 97) varies from size of a pea to that of a hen's egg, and is composed of a hydatid cyst (cuticle thin) which forms numerous small invaginations (as many as 500 in large specimens), in each of which a head develops without the formation of brood capsules; head armed with a double row of 22 to 32 hooks, of two sizes (see description of adult, p. 101). Transmissible to dogs, but not to man.

The Gid Bladder Worm (*C. cerebri*), p. 108.

Parasitic in any organ, particularly the liver and lungs of man, cattle, sheep, swine, etc. Bladder (figs. 101 and 105) varies from size of a pea to that of a child's head, assuming different forms, as described on p. 102; the hydatid cyst has a thick laminated cuticle; the heads are armed with a double row of 28 to 50 hooks, of two sizes (see characters of adult, p. 101), and develop in brood capsules, which are attached to the cyst wall. The adults develop in dogs, but not in man. This is the most important parasite of meat inspection..... The Echinococcus Hydatid (*Echinococcus polymorphus*), p. 113.

Adult tapeworms of Cattle, Sheep, and Swine (?) (Subfamily Anoplocephalinae).

- (18) Posterior border of segments not fringed; parasitic in the intestine..... 19.
- Posterior border of segments fringed (figs. 122 and 124). Parasitic in intestine and bile ducts of sheep. Genital pores double; strobila 15 to 30 cm. long; head large, 1.5 mm. broad, nearly square on apex view; neck flat, broad, and short; broadest segments measure 5 to 8 mm. wide by 0.4 to 0.6 mm. long, and are situated about 2 cm. from posterior end, the end segment showing a decided tendency to become longer and narrower; gravid segments attain 2.2 mm. in thickness; uterus single, transverse, but undulate with cornucopia-like egg pouches; testicles form a band in distal portion of median field; horns of pyriform body around embryo not developed.

The Fringed Tapeworm (*Thysanoxoma actinioides*), p. 128.

¹For characters of the adult form in man, see key, p. 84.

²For characters of the adult form in dogs, see key, p. 101.

³This key to the adult forms is extremely artificial, as characters have been selected which will most easily enable a determination of the worms. For a key expressing more closely the true relations of the forms to each other, see Stiles & Hassall, 1893, p. 88, and Stiles, 1896, p. 214.

- (19) Genital pores double, segments generally quite broad; pyriform body well developed. Parasitic in cattle and sheep. *Moniezia*, 20.
 Genital pores usually single, rarely double, and then only in strobilae, which contain single-pored segments in the majority. Parasitic in sheep, cattle (?), and swine (?).
 Strobila 1 to 2 meters long; head 0.5 to 1 mm. broad; neck absent or present; most of the segments broader than long, only the posterior segments longer than broad; unripe segments often present a zigzag appearance; largest segments 5 to 6.5 mm. broad by 1 to 2 mm. long; testicles divided into two groups and confined for the most part to the lateral fields; uterus same as in the Fringed Tapeworm.

Giard's *Thysanosoma* (Th. Giardi), p. 129.

Genital pores single; segments very narrow. Parasitic in sheep and cattle (?).

Stilesia, 24.

Moniezia.

- (20) Interproglottidal glands absent. Alba group, 21.
 Interproglottidal glands linear (fig. 113). Planissima group, 22.
 Interproglottidal glands circular, groups around blind sacs (fig. 118).

Expansa group, 23.

Neck absent; head large, decidedly lobed; strobila 40 cm. long; segments attain 8 mm. in breadth. Doubtful species, parasitic in sheep. *Moniezia mullicollis*.

- (21) Parasitic in sheep. Strobila nearly half a meter long by 2.5 mm. broad; gravid segments may attain 2.5 mm. broad by 5 mm. long; genital pores in middle or anterior half of lateral margin; cirrus pouch about 0.18 mm. long; eggs 60 μ , pyriform body 20 μ , horns end in a knob. Vogt's *Moniezia* (*M. Vogti*), p. 127.
 Parasitic in sheep and cattle. Strobila 0.60 to 2.5 meters long; head subquadrangular, 1.15 to 1.4 mm. broad; neck 1.5 to 5.3 mm. long; gravid segments attain 8 to 14 mm. broad by 2 to 6.5 mm. long by 1.5 mm. thick; testicles arranged in a quadrangle; eggs 60 to 88 μ , bulb of pyriform body 16 to 24 μ , horns 8 to 20 μ .

The White *Moniezia* (*M. alba*), p. 127.

- (22) Parasitic in cattle and sheep. Strobila (fig. 111) 1 to 2 meters long; yellowish; head 0.4 to 0.9 mm. broad; neck thin, short or long; segments always broader than long; gravid segments attain 12 to 26 mm. broad by 1 to 1.75 mm. long, generally thin and flat; interproglottidal glands large and very distinct; testicles arranged at first in two triangles, in older segments in a quadrangle; 400 to 600 testicles present in a segment; eggs 63 μ , bulb of pyriform body 20 μ , horns 24 μ The Flat *Moniezia* (*M. planissima*), p. 127.

Parasitic in sheep and cattle. Strobila attains 4 meters in length; head about 1 mm.; neck 2 to 2.5 mm. long; suckers very distinctly lobed and sharply separated from neck; segments always broader than long; gravid segments may attain 12 mm. broad by 3 mm. long by 2 mm. thick; interproglottidal glands extremely indistinct; eggs 80 to 85 μ , pyriform body 18 μ Van Beneden's *Moniezia* (*M. Benedeni*), p. 128.

Parasitic in sheep. Strobila 1.5 to 2 feet long; head square, 0.9 mm.; gravid segments attain 8 mm. broad by 1.5 mm. long; but the end segments may measure 6 mm. broad by 2 mm. long; testicles arranged in a quadrangle; interproglottidal glands small; eggs 55 to 65 μ Neumann's *Moniezia* (*M. Neumanni*), p. 128.

- (23) Parasitic in cattle and sheep. Strobila (fig. 116) attains 4 to 5 meters in length; anterior portion usually whitish, posterior portion usually yellowish; head 0.36 to 0.7 mm. broad; segments always much broader than long, gravid segments attaining 16 mm. in width and are quite thick; end segments never as long as broad; testicles usually arranged in a quadrangle, rarely in two triangles except in younger segments; eggs 50 to 60 μ , bulb of pyriform body 20 μ The Broad *Moniezia* (*M. expansa*), p. 128.
 Parasitic in sheep. Strobila (fig. 120) attains 1.6 to 2 meters in length; cream to whitish in color; head 0.6 to 0.7 mm. broad; neck filiform, 2 mm. long; segments generally broader than long, rarely over 6 mm. broad by 2 mm. long; although end segments are occasionally found which are square or even slightly

longer than broad; testicles usually arranged in two triangles; eggs 52 to 60 μ , bulb of pyriform body 20 to 24 μ , horns 12 to 15 μ .

The Triangle Moniezia (*M. trigonophora*), p. 128.

Stilesia.

- (24) *Strobila* transparent, whitish or grayish yellow, 45 to 60 mm. long, not over 2.5 mm. broad; head 0.5 to 1 mm. broad; median portion of median field transparent; two lateral cornucopia-like egg pouches present in each segment.

The Globipunctate Tapeworm (*S. globipunctata*), p. 130.

Strobila attains nearly 3 meters in length, but not over 3 mm. in breadth; head 1.5 to 2 mm. broad; median field occupied by transverse uterus.

The Centripunctate Tapeworm (*S. centripunctata*), p. 130.

FLUKES, OR TREMATODES (Order Trematoda).

The following technical description shows the systematic position and general structure of the flukes under discussion:

[Suborder Malacocotylea: Digenea. Families Fasciolidae and Amphistomidae.
See figs. 3, 29, 30, 37, 41, 42, 43, and 50.]

With the exception of the Blood Flukes (*Schistosoma*), they are all hermaphrodites. They are flat or conical worms, always longer than broad; on the anterior extremity is situated the mouth, surrounded by a muscular organ, known as the *oral sucker* and curved slightly ventrad. There is a second sucker (the *acetabulum*), which is situated in the median ventral line; in the Fasciolidae the acetabulum is generally found on the anterior half of the body, while in the family Amphistomidae it is at or near the posterior extremity. The surface of the worms is generally more or less covered with minute spines, or tubercles.

The *digestive tract* consists of the mouth, a short oesophagus, and two blind sacs (*intestinal caeca*), which represent the true intestine. The anterior portion of the oesophagus is generally connected with the mouth by a muscular bulb (the *pharynx*); the posterior extremity bifurcates, one branch being connected with each intestinal caecum. The intestinal sacs are usually simple elongated tubes, but in the genus *Fasciola* they branch freely (fig. 29). In *Schistosoma* the two caeca unite after passing the acetabulum. An anus is never present.

Genital organs.—The *genital pore* is in the ventral median line in all species here described, the male copulatory organ (*cirrus* or penis) lying very close to the female opening (*rudra*). *Male organs*: A cirrus is frequently seen extruded from the genital pore, and in those cases it appears as a curved organ, varying in size according to the species; usually the cirrus is invaginated in the *cirrus pouch*. Through its center runs a canal (the *ductus ejaculatorius*) which receives the spermatozoa from a *resicula seminalis*. The latter is partially or entirely included in the pouch; at its posterior end it receives the two *vasa deferentia*, through which the spermatozoa are conducted from the testicles. The testicles, generally two in number, one right and one left, are more or less round, lobed, or branched. *Female organs*: The vulva leads into a canal, the anterior portion of which is known as the *metratrum*; this is continued as the *uterus*, which forms more or less numerous folds in the median portion of the body and finally leads to the so-called *shell-gland* which may frequently be seen in fresh specimens (*F. magna* and others) as a round body a short distance posterior of the acetabulum. In the center of the shell gland is a canal (the *ootyp*), in which four canals (*uterus*, *oviduct*, *Laurer's canal*, and *vitello-duct*) come together. The *ovary* in some species is globular, in others branched, and connects with the ootyp through the *oviduct*. The *Laurer's canal* runs from the ootyp dorsad in curves and opens to the exterior on the dorsal surface; its function is still doubtful, but

homologically it represents the uterus of cestodes. The *vitellogene glands* are two in number and are situated laterally of the longitudinal intestinal tubes; they vary in size in different species, are generally quite elongated, and are composed of numerous branches much like a bunch of grapes in form, all of which connect with a longitudinal *vitello-duct* (one on each side of the body); these longitudinal ducts are in turn connected by a pair of transverse ducts which unite in the median line, immediately posterior of the shell-gland, to form a common reservoir; this in turn empties into the ootyp through the short vitello-duct mentioned above. The vitellogene glands produce yolk cells which are associated with the true ovum to form the eggs.

Excretory system.—At or near the posterior extremity, generally somewhat dorsally, is situated a small pore (*porus excretorius*), which leads into a *median terminal vesicle*; this latter gives off longitudinal branches; these in turn give off secondary branches which ramify throughout the body, each small branch ending in an excretory organ.

Nervous system.—A set of ganglia is found at each side of the pharynx; these ganglia are connected by a dorsal commissure and give off numerous nerves to various parts of the body. The largest nerves are the two ventral longitudinal nerves which run antero-posteriorly, and can frequently be seen in fresh specimens.

Development.—See p. 30.

Cattle (*Bos taurus*) are alleged to be infested with fifteen kinds of flukes, only two of which, the Large American Fluke and the Common Liver Fluke, are positively known to occur in the United States. Osler has found the Conical Fluke at Montreal, where it was not uncommon; he also found the same parasite in cattle in Nova Scotia.

Sheep (*Ovis aries*) are infested with five known species of flukes, only one of which, the Common Liver Fluke, is known to be in the United States; the Conical Fluke, as stated above, is found in Canada.

Hogs (*Sus scrofa domestica*) harbor three known species of flukes, only one of which, the Common Liver Fluke, is found in the United States. Willach (1893) has described a *Monostomum hepaticum suis* from the liver of hogs; this supposed fluke is evidently a partially developed bladder worm (*Cysticercus tenuicollis*) (see p. 96).

DISTOMES (Flukes of the Family Fasciolidae).

Hermaphroditic Distomes (Flukes of the Subfamily Fasciolinae).

AGAMIC, OR IMMATURE, DISTOMES (Genus *Agamodistomum*).

This is a purely artificial group, of biologic rather than systematic nature. One immature fluke is occasionally found encysted in the muscles of hogs.

1. The Muscle Fluke of Swine (*Agamodistomum suis*).

[Fig. 1.]

SYNONYMY.—*Distomum musculorum suis* Düncker, 1896.

BIBLIOGRAPHY.—Düncker (1896).

This small (0.5 mm. to 0.7 mm. long by 0.2 mm. broad) parasite was discovered in 1881 by G. Leunis (a trichina inspector in Saxony), and has since been found by several other trichina inspectors of Germany. As it appears never to have been binomially named, I propose to call it

Agamodistomum suis. The worm lies free or encysted in the connective tissue between the muscle fibers; it is exceedingly rare and is of no known practical importance in meat inspection, except that in a superficial and careless microscopic examination it might be mistaken for sarcosporidia, or possibly for trichinae. Nothing is known of its life history, but it is supposed to be a purely accidental parasite in swine. We are not aware of its ever having been recorded in this country.

FASCIOLES (Distomes of the Genus *Fasciola*).

The genus *Fasciola* contains the large, flounder-like parasites found especially in the liver of herbivorous animals and known under the general term "liver flukes." Of these Fascioles, or "liver flukes," we find two forms in American cattle (*F. magna* and *F. hepatica*), one form (*F. hepatica*) in American sheep, while a third form (*F. Jacksoni*¹) has been found in North America, South America, and in India in the liver of elephants, and a fourth form (*F. gigantea*¹) is described by Cobbold from the liver of the giraffe. It is quite generally admitted that these Fascioles, owing to their larger size, are more harmful than other flukes.

Until a short time ago it was supposed that we had but one form of fluke in American cattle, but Hassall (1891) and Francis (1891) showed, almost simultaneously, that two distinct forms are found, one form (*F. hepatica*) being present in the liver, very rarely in the lungs, the other (*F. magna*), a much larger worm, infesting both liver and lungs.

2. The Common Liver Fluke (*Fasciola hepatica*) of Cattle, Sheep, Swine, etc.

[Figs. 2-22.]

For anatomical characters, compare fig. 3 with key, p. 21.



FIG. 2.—The Common Liver Fluke (*Fasciola hepatica*), natural size (original).

VERNACULAR NAMES.—English, *Common Liver Fluke*; German, *Leberegel*, *Leberwurm*, *Schäfelgel*; Dutch, *Botten*, *Leverwurm*; Danish, *Faareflynder*; Swedish, *Levermask*; French, *Douve hépatique*, *fasciole*; Italian, *Biscuola*, *distoma epatico*; Spanish, *Caracolillo*.

SYNONYMY.—*Fasciola hepatica* Linnaeus, 1758; *Planaria latiuscula* Goetze, 1782; *Distoma hepaticum* (Linnaeus) Abildgaard (?); *Fasciola humana* Gmelin, 1790; *Distoma (Cladocoelium) hepaticum* (Linnaeus) of Dujardin, 1845; *Fasciolaria hepatica* (Linnaeus) anonymous, 1845; *Distomum hepaticum* (Linnaeus) Diesing, 1850; *Distomum (Fasciola) hepaticum* Linnaeus of Leuckart, 1863; *Cladocoelium hepaticum* (Linnaeus) Stossich, 1892.

BIBLIOGRAPHY.—For bibliography, see Hassall (1894) and Huber (1894). For more technical discussion of species, see Leuckart (1889, pp. 179-328).

GEOGRAPHICAL DISTRIBUTION.—Cosmopolitan.

HOSTS.—Man, cattle, sheep, swine, and other animals. (See pp. 137-143.)



FIG. 1.—The Muscle Fluke (*Agamodistomum suis*), occasionally found in the muscle of swine. (After Leuckart, 1889, p. 155, fig. 86.)

¹ For a discussion of these forms, see Stiles, 1894-1895.

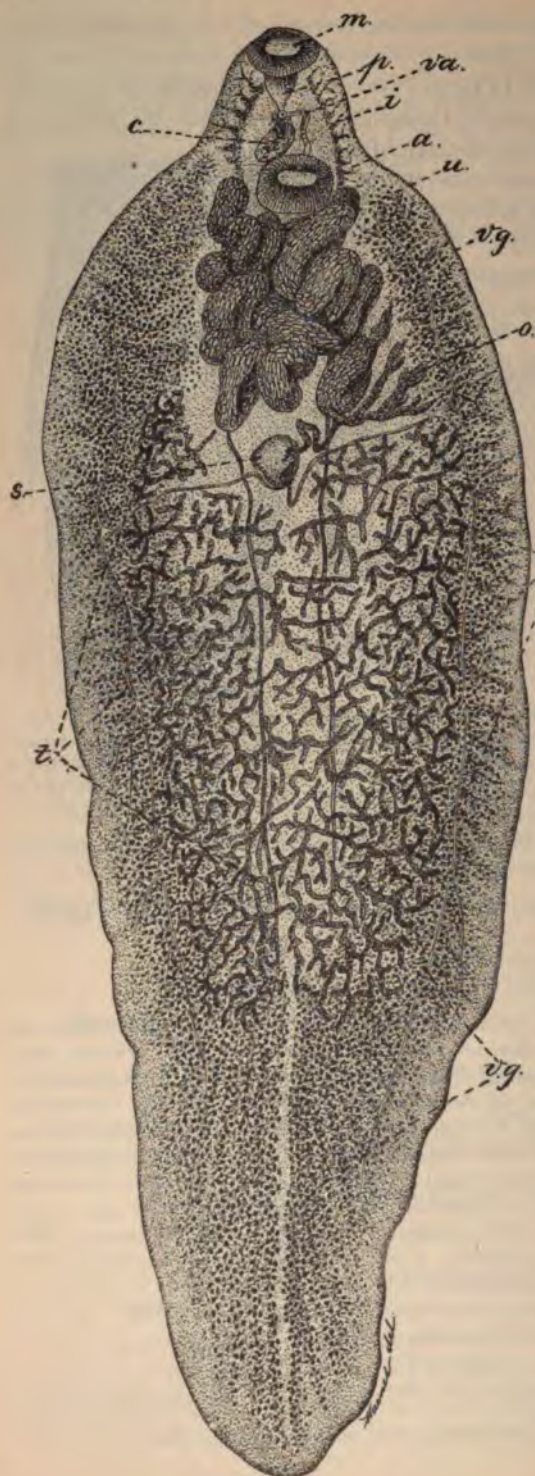


FIG. 3.—The Common Liver Fluke (*Fasciola hepatica*), enlarged to show the anatomical characters: *a*, acetabulum; *c*, cirrus pouch; *i*, intestine; *m*, mouth with oral sucker; *o*, ovary; *p*, pharyngeal bulb; *s*, shell gland; *t*, profusely branched testis; *u*, uterus; *va*, vagina; *vg*, profusely branched vitelline gland. (After Siles, 1894, p. 300.)

Life history.—The life cycle of this fluke, as determined by the investigations of Creplin (1837), Weinland, Leuckart (1863, 1879, 1880, 1881, 1882), and Thomas (1882, 1883), is exceedingly interesting; at the same time it is very complicated, for the adult parasite, instead of producing young similar to itself and capable of developing directly into adults in cattle, produces eggs which develop into organisms totally different from the adult form living a parasitic life in other animals. In scientific language, the parasite is subject to an alternation of generations, together with a change of hosts. The following summary of the life history will make this point clear:

(a) The adult hermaphroditic worm (figs. 2 and 3), the characters of which are given on p. 22, fertilizes itself (although a cross fertilization of two individuals is not impossible) in the biliary

passages of the liver, and produces a large number (estimated at 37,000 to 45,000) of eggs.

(b) *Eggs* (figs. 4 and 5).—Each egg is composed of the following parts: (1) A true germ cell, which originates in the ovary and is destined to give rise to the future embryo; (2) a number of vitelline or yolk cells, which are formed in a specialized and independent portion (vitellogene gland) of the female glands; instead of developing into embryos, the yolk cells form a follicle-like covering for the true germ cell and play an important rôle in the nutrition of the latter as it undergoes further development; (3) a shell surrounding the germ cell and vitelline cells, and provided at one end with a cap or operculum. The eggs escape from the uterus of the adult through the vulva, are carried to the intestine of the host with the bile, then pass through the intestines with the contents of the latter, and are expelled from the host with the faecal

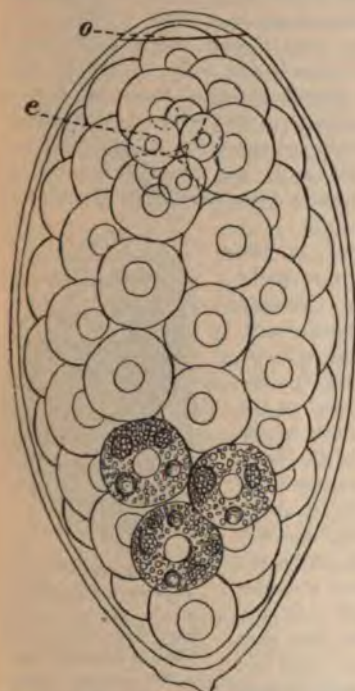


FIG. 4.—Egg of the Common Liver Fluke (*Fasciola hepatica*) examined shortly after it was taken from the liver of a sheep; at one end is seen the lid or operculum, *o*; near it is the segmenting ovum, *e*; the rest of the space is occupied by yolk cells which serve as food; all are granular, but only three are thus drawn. $\times 680$. (After Thomas, 1883, p. 281, fig. 1.)

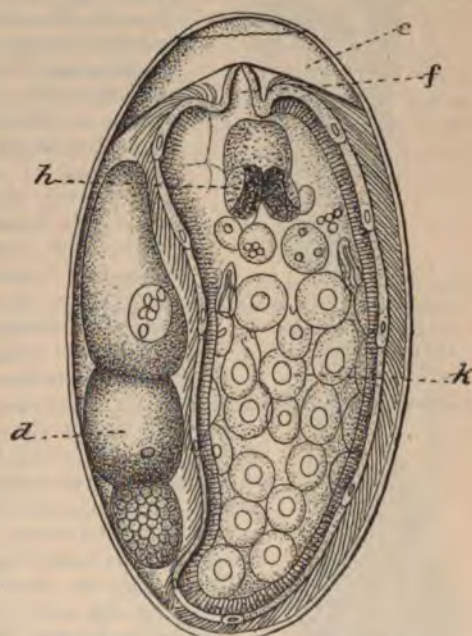


FIG. 5.—Egg of the Common Liver Fluke containing a ciliated embryo (miracidium) ready to hatch out; *d*, remains of food; *e*, cushion of jelly-like substance; *f*, boring papilla; *h*, eye-spots; *k*, germinal cells. $\times 680$. (After Thomas, 1883, p. 283, fig. 2.)

matter. Many of them become dried and then undergo no further development, but others are naturally dropped in the water in marshes, or, being dropped on dry ground, they are washed into the water by the rain, or are carried to a more favorable position by the feet of animals pasturing or passing through the fields. After a longer or shorter period of incubation, which varies with the temperature, a ciliated embryo (*miracidium*) is developed. At a temperature of 20° to 26° C. the miracidium may be formed in 10 days to 3 weeks; at a temperature of 16° C. the development takes 2 to 3 months; at 38° C. it ceases entirely. Experiments have

shown that as long as these eggs remain in the dark the miracidium will not escape from the eggshell; accordingly it will not escape during the night. When exposed to the light, however, or when suddenly brought into contact with cold water, the organism bursts the cap from the eggshell, crawls through the opening, and becomes a—

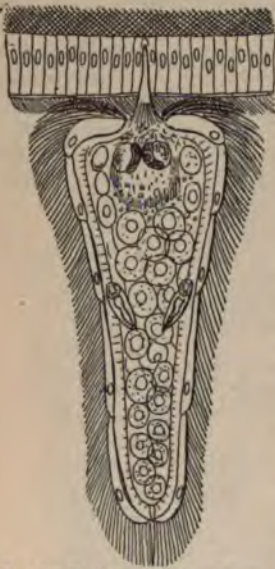


FIG. 6.—Embryo of the Common Liver Fluke (*Fasciola hepatica*) boring into a snail. $\times 370$. (After Thomas, 1883, p. 285, fig. 4.)



FIG. 8.—Sporocyst of the Common Liver Fluke, somewhat older than that of fig. 7, in which the germinal cells are giving rise to rediae. $\times 200$. (After Leuckart, 1889, p. 109, fig. 67 C.)

(c) *Free-swimming ciliated miracidium* (fig. 6).—As already stated, this organism is entirely different from its mother. It measures about 0.15 mm. long; it is somewhat broader in its anterior portion than in its posterior portion; on its anterior extremity we find a small eminence known as a boring papilla; the exterior surface of the young worm is covered with numerous cilia, which by their motion propel the animal through the water; inside the body we find in the anterior portion a simple vestigial intestine and a double ganglionic mass, provided with a peculiar pigmented double cup-shaped eye-spot; in the posterior portion of the body cavity are found a number of germ cells, which develop into individuals of the next generation.

Swimming around in the water, the miracidium seeks out certain snails (*Limnaea truncatula*, *L. oahuensis*, *L. rubella*, see p. 43), which it immediately attacks (fig. 6). The miracidium elongates its papilla and fastens itself to the feelers, head, foot, or other exterior soft portion of the body of the snail; some of the parasites enter the pallial (lung) cavity and attach themselves there. After becoming securely fastened to the snail the miracidium discards its ciliated covering and shortens to about half its former length (0.07 mm. to 0.08 mm.). The parasites now bore their way into the body of the snail and come to rest in the liver, or near the roof of the pallial cavity, etc., the movements gradually cease, and we have before us the stage known as the—

(d) *Sporocyst* (figs. 7 and 8).—The eye-spots, ganglionic swellings, and vestigial intestine become more and more indistinct and are finally lost. The sporocyst grows slowly at first, then more rapidly, and at the end of 14 days or so measures about 0.5 mm. The germ cells mentioned as existing in the posterior portion of the miracidium now develop into individuals of a third generation, known as—

(e) *Rediae* (figs. 9 and 10).—The rediae escape from the sporocyst when the latter are from two weeks (in summer) to four weeks (in late fall) old. Upon leaving the body of the sporocyst they wander to the liver of the snail, where they grow to about 2 mm. long by 0.25 mm. broad. Each redia consists of a cephalic portion, which is extremely motile, and which is separated from the rest of the young worm by a ridge; under the latter is situated an opening, through which the next generation (cercariae) escape. The posterior portion of the



FIG. 7.—Sporocyst of the Common Liver Fluke which has developed from the embryo, and contains germinal cells. $\times 200$. (After Leuckart, 1889, p. 109, fig. 67 B.)

the rest of the young worm by a ridge; under the latter is situated an opening, through which the next generation (cercariae) escape. The posterior portion of the

worm is provided, at about the border of the third and the last fourths of the body, with two projections. There is a mouth with pharynx situated at the anterior extremity, the pharynx leading into a simple blind intestinal sac. The redia, as well as the sporocyst, may be looked upon as a female organism, and in its body cavity are found a number of germ cells, which develop into the individuals of the next generation, known as—



FIG. 9.—Redia of the Common Liver Fluke (*Fasciola hepatica*), containing germinal cells which are developing into cercariae. $\times 150$. (After Leuckart, 1889, p. 269, fig. 129 A.)

as some believe, through the portal veins to the liver, where it develops into the adult hermaphrodite.

From the above we see that this parasite runs through three generations, namely:

- (1) Ovum, miracidium, and sporocyst.... first generation.
- (2) Redia.... second generation.
- (3) Cercaria and adult.... third generation.

During this curious development, which lasts about 10 to 12 weeks, there is a constant potential increase in the number of individuals, for each sporocyst may give rise to several (5 to 8) rediae, each redia to a larger number (12 to 20) cercariae, and each adult to an enormous number (37,000 to 45,000) of eggs. This unusual fertility of the animal

is necessary because of the complicated life history and the comparatively small chance any one egg has of completing the entire cycle.

(f) *Cercariae* (figs. 11-13).—These organisms are quite similar to the adult parasites into which they later develop. The body is flat, more or less oval, and provided with a tail inserted at the posterior extremity. The oral sucker and acetabulum are present as in the adult, but the intestinal tract is very simple; on the sides of the body are seen two large glands, but the complicated genital organs of the adult are not visible. The cercaria leaves the redia through the birth opening, remains in the snail for a longer or shorter time, or passes out of the body of the snail and swims around in the water. After a time it attaches itself to a blade of grass (fig. 12) or some other object, and forms a cyst around itself with material from the large glands, at the same time losing its tail. It now remains quiet until swallowed by some animal. Then, upon arriving in the stomach—of a steer, for instance—the cyst is destroyed, and the young parasite wanders through the gall ducts or,



FIG. 10.—Redia of the Common Liver Fluke, with developed cercariae. $\times 150$. (After Leuckart, 1889, p. 270, fig. 130.)



FIG. 11.—Free cercaria of the Common Liver Fluke, showing two suckers, intestine, large glands, and tail. (After Leuckart, 1889, p. 270, fig. 137.)

Hosts.—An interesting and, from an agricultural standpoint, an important matter connected with this fluke is that it is found in a large number (about 25) of domesticated and wild animals, and this fact probably explains to some degree the wide geographical distribution of the parasite.

THE EFFECTS OF THE COMMON LIVER FLUKE UPON CATTLE, SHEEP,
AND SWINE.

This worm is one of the most important and dangerous parasites with which the stock raiser has to deal, since it produces a disease which often results in heavy loss of live stock, especially of sheep. Although it does not seem as yet to have caused any such serious epizootics in this country as have been reported in Europe, sweeping out or greatly retarding the live-stock industry, we should not wait until such an occasion arises before we consider the importance of this subject. We know that *F. hepatica* is present in the country; furthermore, that it is common in some places (Texas and elsewhere), and we would do well to inquire into the injury which other countries have sustained as a warning that we must not totally ignore its presence among us.

The following are among the most important outbreaks¹ recorded:

Wernicke (1886) records that not less than 1,000,000 sheep died of fluke disease in the southerly provinces of Buenos Ayres during 1882; in 1886 more than 100,000 head died in Tandil during eight months.

Youatt estimated the annual loss in Great Britain at 1,000,000 sheep. For 1879 and 1880, a loss of 3,000,000 head per year was estimated for England alone.

During 1876, Slavonia lost 40 per cent of her cattle from distomatosis.

In 1830, England lost 3,000,000 sheep from this disease, estimated at a value of \$20,000,000.

In 1829 and 1830, 5,000 of the 25,000 cattle of Montmédy perished; in Verdun, 2,200 cattle and nearly 20,000 sheep, out of 20,000 cattle and 50,000 sheep, succumbed to the parasite.

Names of the disease.—The presence of these flukes in the liver of animals gives rise to a disease known under the various names of rot, liver-rot, rot-dropsy, fluke disease, aqueous cachexia, cachexia aquosa verminosa, fascioliasis, distomatosis, etc.

The term *rot*, as used by farmers and by some veterinarians, is an exceedingly broad one; in many parts of this country almost any disease of sheep is called rot. We have met nodular disease of the intestine and other diseases under this term. On this account it must not be supposed that every article on rot refers to liver-fluke disease.

Symptoms.—There is no one special symptom which is characteristic of this disease and absent from all others; in fact liver rot in its various stages might easily be mistaken for other parasitic complaints.

(A) *The disease in sheep.*—Gerlach has divided the malady into four periods, and although this division is more or less artificial, since the different stages gradate imperceptibly into each other and are obscured

¹ For a more complete list of epizootics, see Hassall, 1894.

on account of the constant liability to further infection, we give Gerlach's scheme here as a convenient diagram of the disease:

These symptoms are taken chiefly from sheep, but the same description applies in a general manner to the same disease in other animals:

(1) *Period of immigration* (stage of traumatic hepatic inflammation, inflammatory swelling of the liver).—July to September, lasting about 13 weeks. This is the period of infection, but as the

symptoms are not generally very pronounced (the pathological lesions produced by the flukes not having as yet affected the system of the host) it generally escapes notice. At first a redness of the eyes, which, however, soon disappears; paleness. Death from apoplexy sometimes occurs. The presence of the flukes in the liver irritates this organ and causes an increased blood supply (hyperaemia) and consequent enlargement of the liver. The surface is smooth, marked with small openings, out of

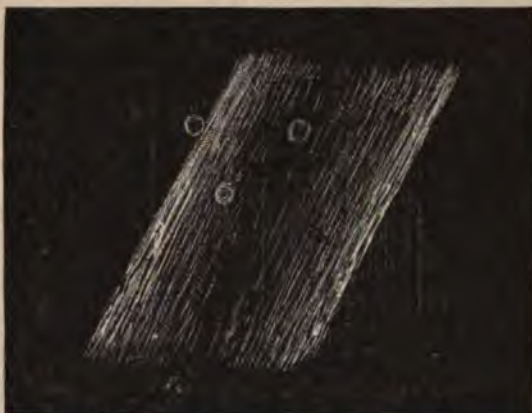


FIG. 12.—Portion of a grass stalk with three encysted cercariae of the Common Liver Fluke (*Fasciola hepatica*). $\times 10$. (After Thomas, 1883, p. 291, fig. 13.)

which may be pressed a bloody serum, and around these openings there is frequently an inflammation of the peritoneum (localized peritonitis). Gall ducts still about normal; gall more or less bloody; hemorrhagic centers in parenchyma; bloody serous exudate in abdominal cavity, in which flukes are occasionally found. No eggs present as yet in droppings.

(2) *Period of anaemia*.—September to December, 6 to 12 weeks. The visible mucous membranes (around the eyes, nose, and gums) and the skin are paler than usual. Animals have a tendency to fatten. Appetite may be very good, but afterwards diminishes and rumination becomes irregular; slight oedema; bare skin soft to the touch, loose and pasty; eyes become "fat," i. e., they are partially closed, the conjunctiva becoming puffy; gradual loss of strength; fever and accelerated respiration; death in this stage seldom.



FIG. 13.—Isolated encysted cercaria of the Common Liver Fluke. $\times 150$. (After Leuckart, 1889, p. 286, fig. 142.)

Liver pale, increased considerably in size, especially in thickness; its capsule rough, opaque; its parenchyma soft with an appearance like porphyry, with hemorrhagic centers; here and there channels caused by parasites; numerous eggs in faeces.

(3) *Period of emaciation* (stage of atrophy of the liver).—January to May. Disease is at its height; extreme anaemia and emaciation; respiration feeble and quickened; temperature variable; abortions frequent; "puffiness" (oedema) especially frequent under the jaws; mortality high.

Atrophy of liver in various stages; gall ducts greatly thickened, frequently with calcareous incrustations; petechiae beneath endocardium; bile thick, dirty brown, with numerous eggs.

(4) *Period of emigration of the flukes*.—May to July. The flukes leave the liver and are passed with the droppings. The symptoms diminish, but the scars, the result of the inflammatory processes, remain.

Zündel makes a slightly different division of the periods of the disease, but, as in the division proposed by Gerlach, it is not to be followed too rigidly, as the different periods are not sharply defined from one another. Zündel's four periods are:

First period.—Stage of inflammation, inflammatory swelling of the liver: August to October. The presence of the flukes causes an irritation; profuse flow of gall mixed with blood. Generally passes unnoticed.

Second period.—Stage of contraction of the liver: September to November, 6 to 12 weeks. Flukes collected in groups partially obstruct the bile ducts, whose irritated mucosa is thickened; anaemia, cachexia, general weakness, discoloration of the tissues.

Third period.—Stage of atrophy of the liver: January to March. Cachexia; high mortality. Flukes mature; gall ducts greatly thickened and hardened. Liver atrophies in some places, swells in others.

Fourth period.—Stage in which the flukes leave the liver: April to June.

(B) *The disease in cattle.*—The first symptoms are generally overlooked, the disease not attracting attention until the appetite is diminished, rumination becomes irregular, the animals become hidebound, and the coat dull and staring. The staring coat is due to the contraction of the muscles of the hair follicles. The visible mucous membranes become pale, eyes become dull, there is running at the eyes, and the animal gradually becomes emaciated. As the disease advances the milk supply is lessened, fever appears, there is generally great thirst, but the appetite almost ceases; oedematous swellings appear on the belly, breast, etc.; diarrhoea at first alternates with constipation, but finally becomes continuous. The disease lasts from 2 to 5 months, when the most extreme cases succumb.

Ostertag (1895, p. 357) states that most of the European cattle are infested with liver flukes, but that even when a large number are present the nourishment of the cattle is not disturbed. Thickening of the gall ducts, so that a so-called "Medusa's head" forms on the surface of the liver toward the stomach, appears in even well-nourished animals; even in cases of a cirrhosis of the liver it is seldom that any effect upon the cattle's health can be noticed, and as long as a portion of the liver tissue, about twice the size of the fist, remains intact the nourishment of the animal may be comparatively good. Ostertag, in all of his experience, has never seen a generalized oedema in slaughtered cattle as a result of fluke invasion, and even in the heaviest infections of young cattle he has noticed only emaciation.

(C) *The disease in hogs.*—The Common Liver Fluke is a comparatively rare parasite in swine and apparently of very little importance.

Pathology.—The pathological lesions are directly dependent upon the presence of the flukes in the body, and as the liver is the chief abode of the parasites, we should accordingly expect to find that this organ is more affected than any other, and the seat of the primary lesions; also that the symptoms and changes noticed in other organs are in nearly all cases directly dependent upon the changes in the liver; furthermore,

that the extent of the lesions is dependent upon the number of parasites present. The size of the worms and the size of the spines found on them are two important factors in determining the extent of the lesions.

By their presence and wanderings in the gall ducts the parasites irritate the mucosa and cause an inflammation accompanied by an increased secretion, leading to a desquamative catarrh; this inflammation causes a thickening of the mucosa with growth of its glandular elements (glandular hyperplasia) and submucosa. The young parasites make their way into the smaller ducts, rolling their body dorsally and here singly, or in the larger ducts in groups, they cause a dilatation of the ducts, in some cases forming cysts. There is a hyperplasia of the connective tissue



FIG. 14.—Drawing from a microscopic preparation showing a hemorrhage in the parenchyma of the liver caused by the Common Liver Fluke (*Fasciola hepatica*): a, atrophic liver tissue; b, round cell infiltration; c, a portion of the parasite; d, hemorrhage. (After Schaper, 1890, PL I, fig. 1.)

and a cellular infiltration, together with an increased development of the blood capillaries. The inflammatory process extends from the duct walls to the interlobular connective tissue, accompanied by atrophy of the parenchyma. A slight atrophy of the parenchyma, with an extensive hypertrophy of the connective tissue and an extensive infiltration and increased blood supply, naturally causes an increase in the size of the liver. With the decrease of the hyperplastic tissue and the consequent compression and destruction of the capillaries the cirrhotic and atrophic processes become evident. An advancing hyperplasia of the connective tissue destroys the parenchymatic cells of the lobules, leaving in many cases only a clump of gall pigment as evidence of a former lobule. Gradually a smaller or larger portion of the liver is changed into a mass of cicatricial tissue surrounding stiff tubes—the metamorphosed gall ducts.

Besides the lesions thus far described, due for the most part to the changes in the gall ducts, other changes are found due directly to the action of the parasites upon the parenchyma of the liver, namely, a breaking down of the liver tissue, paren-

chymatic hemorrhages, pus infiltrations, and abscess formations. The flukes may break through a smaller gall duct, or may penetrate one of the larger ducts at a weak point, and wander directly through the soft glandular tissue; the mechanical injury to the tissue results in its necrosis; blood vessels are also injured, giving rise to multiple hemorrhages, which may discharge through the gall ducts and aid in producing the general anaemia. Inflammation naturally follows the flukes in their wanderings, leading to a liquefaction of the tissue and formation of abscesses, in which bacteria (streptococci and staphylococci) are found, the organisms having come from the inflamed bile ducts. With this inflammation going on it is but natural that the walls of some of the blood vessels should be affected, thus making it possible for the flukes to gain access to the circulation, with which they might be



FIG. 15.—Drawing from a microscopic preparation showing the glandular hyperplasia of the mucosa of a gall duct caused by the Common Liver Fluke (*Fasciola hepatica*): a, hypertrophied submucosa; b, interstitial connective tissue; c, compressed lobule; d, lumen of the gall duct; thickened fibrous wall of the gall duct. (After Schaper, 1890, Pl. I, fig. 2.)

carried to various parts of the body, lungs, brain, etc., causing endophlebitis, endarteritis, ruptures, thrombosis, emboli, abscesses, etc.; pyaemic or septicopyaemic processes may extend from the liver, and finally the flukes in their wanderings may perforate the capsule of the liver, causing perihepatitis or peritonitis.

These various pathological lesions naturally act upon the circulatory system. The branches of the portal veins and vena cava are compressed or obliterated to a certain extent, and ascites and oedema follow.

The bile is greatly changed, becoming more or less thick, greenish brown, or dirty red, and containing epithelial, parenchymatic, and blood cells, leucocytes, bacteria, fluke eggs, etc., according to the processes going on in the liver.

The hemorrhages, lack of sufficient gall, consequent disorder in digestion, pathological changes, etc., rapidly lead to a general cachexia, weakness, and emaciation.

In animals infested with flukes it has been noticed that the blood is poor in haemoglobin and that the number of blood corpuscles is below the normal.

For a more detailed discussion, see Schaper (1890).

As already stated, the symptoms and pathology here given are based chiefly upon observations made on sheep, but what has been said of the disease in sheep may also be said of the disease in cattle, except that the latter, on account of their greater strength, can better withstand the attack, and the symptoms are accordingly not so marked.

Diagnosis.—Flukes are said to be found in the faecal matter during the fourth stage, but their eggs may be found much earlier. Accordingly, if fluke disease is suspected a positive diagnosis may be made by



FIG. 16.—Drawing from a microscopic preparation showing a fluke in the tissue of the liver: *a*, necrotic liver tissue; *b*, atrophic liver cells; *c*, spines on the fluke, showing the outline of the body. (After Schaper, 1890, Pl. III, fig. 5.)

a microscopic examination of the faeces to find the ova. In order to do this it is often sufficient to place a minute portion of faecal matter on a slide, add a drop of water, and examine under a low-power lens.

An easy method of concentrating the eggs in a given amount of manure to be examined, so that the microscopic examination will be facilitated, is to place the faecal matter in a jar of water, shake well, filter through a wire net, and allow it to settle. The fluke eggs will settle on the bottom with the heavier matter, but a great deal of vegetable material will be caught by the wire netting or will float. The part which floats can then be drained off with water, leaving the eggs in the more solid matter, which can then be examined microscopically.

If facilities for a microscopic examination are not at hand, it is best to sacrifice one of the animals of the herd—the one in which the symptoms are most pronounced—and examine its liver for flukes.

Position of the parasites.—For the most part the flukes are confined to the gall ducts; some, however, are found in the parenchyma of the liver; a few reach the portal veins and cause endophlebitis, thrombosis, and emboli; others enter the liver veins and are carried to various parts of the body; upon passing the heart they reach the lungs, where they can give rise to hemorrhagic centers, canals with bloody contents, or even nodules. From the pulmonary arteries they could reach the pulmonary veins, and from there may be carried by the blood to any part of the body. The presence of flukes in peripheral portions of the body is, however, exceptional.

Influence of age.—It has been noticed in epizootics that calves and cattle under three years are more seriously affected by the disease than are older animals. This is undoubtedly due to the fact that the older animals are stronger, and hence are able to resist more.

It has, however, been shown that very young calves are comparatively rarely infested with flukes (see fig. 17); a fact which is easily understood when we recall that they are, from their mode of life, food, etc., less exposed to the infection than the older animals, which live almost entirely upon pasture, and, taking in a great amount of grass, naturally stand in danger of swallowing a greater number of the cercariae. Bulls which are kept close are generally free from these worms.

Geographical distribution; fluky years and fluky seasons.—This parasite has a very wide distribution, being found in Europe, Asia, Africa, North America, and South America. As a general rule, it can be said that the parasite is found on the lowlands—marshes, valleys, etc.—but is generally absent from the highlands; and this is in accordance with the facts observed in connection with the life history, for the intermediate host is a snail which lives in marshes and marshy districts, but is generally absent from the dry highlands. With this same general law of distribution, dependent upon the physical geography of the country, we can correlate two other general statements in regard to the occurrence of the parasite, and hence of the disease, based upon the humidity of the season—namely, fluke disease is more frequent in wet years (“fluky years”) than in dry years, and fluke disease is more prevalent after the wet months of the year than after the dry months.

In wet years, namely, in years of heavy rainfall, the overflow of water naturally extends the limits of marshes and carries the snails over a greater area. Furthermore, the ground being more moist, the eggs have greater chances for development, and the infection is thus spread.

An idea of the frequency of the parasites during different months of the year may be obtained from an examination of fig. 17. On this chart Leuckart has plotted the animals slaughtered at the Berlin abattoirs during the years 1883–84, according to statistics furnished by Hertwig. The table covers 94,387 head of cattle and 77,848 calves. Of the cattle,

about three-fourths to four-fifths were infested with flukes, and of these 3,428 were so badly infested that their livers were condemned. Of the calves, only 154 livers were condemned.

The table shows us that the parasites are present the entire year; also that there are two periods during the year, namely, from October to January (highest in October) and from March to April, in which the

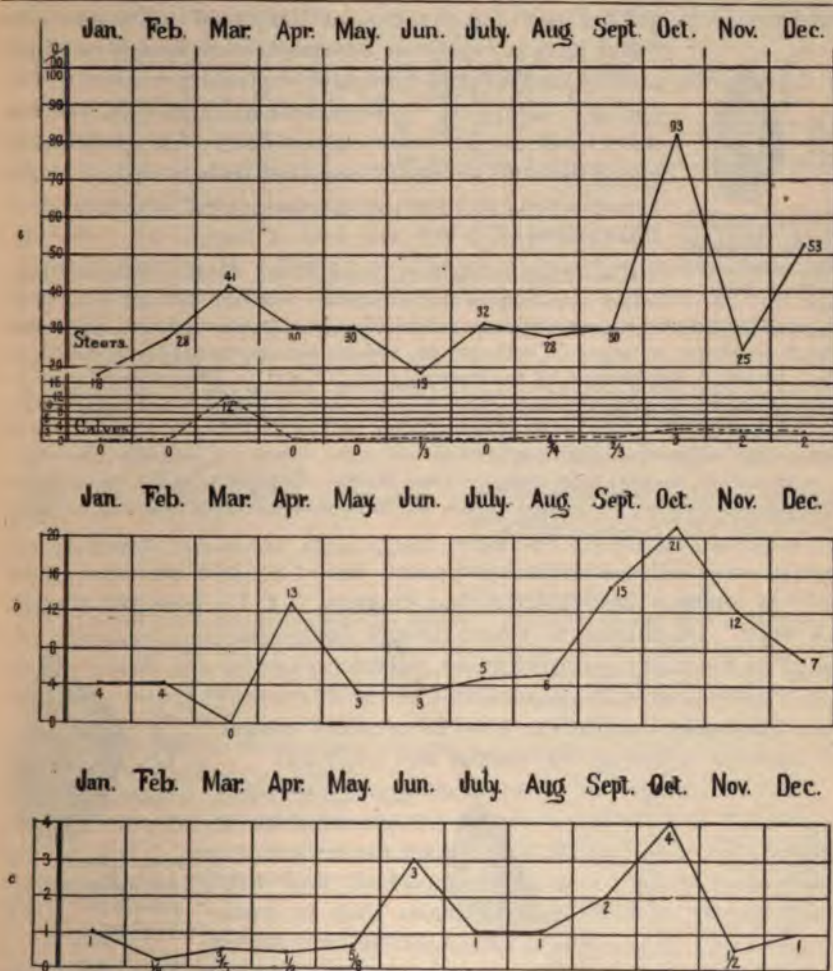


FIG. 17.—Tabular diagram of the occurrence of the Common Liver Fluke (*Fasciola hepatica*) during different months of the year: a, cattle; b, sheep; c, swine. (After Leuckart, 1889, p. 301, fig. 147.)

livers are particularly infested, or so altered as not to be fit for food. Leuckart has interpreted these figures as signifying that the winter maximum pointed to an infection in the fall, while the summer maximum pointed to one in early spring, namely, during the wettest seasons of the year.

According to Lutz (1892), Oahu and Kauai of the Sandwich Islands suffer considerably from fascioliasis. In some parts of Oahu nearly all the cattle have been destroyed by the disease; the sheep from dry districts, however, are not affected. Of 602 calves examined at Honolulu, 298 were found infested; of 2,186 cattle, 1,313 were infested, so that about four-sevenths of the animals were diseased.

In this country we have no exact statistics covering this parasite, but Francis, in writing upon the presence of the worm in Texas, states

"that it is exceptional to find a liver free from them at any time of the year, and especially so during the spring;" also, that "heifers coming 2 years old suffered more than at any other age. Many of the cattle and sheep die, and many of those that recover do not thrive the following summer, but remain poor and weak and fail to breed."



FIG. 18.—*Limnaea truncatula*, natural size and enlarged. (After Leuckart.)

Most American authors (Hassall and Francis excepted) have failed to recognize the difference between this species and *F. magna*, so it is in many cases impossible to determine whether an author had before him *F. hepatica* or *F. magna*, or both species, and on this account it is impossible to give the exact distribution of the worms in this country. That it is common in Texas is shown by Francis' article, and I have found the same parasite quite common (August, 1893) in Texan cattle slaughtered at Chicago. I have also found it in other than Texas cattle, although I can not state where the animals came from. Law records *F. hepatica* from sheep on Long Island. Curtice is of the opinion that *F. hepatica* is rare in the United States, but says that in sheep it is "reported by sheep books and newspaper articles."

Time of infection.—Gerlach supposed that the infection takes place only in summer and fall, but the diagram (fig. 17) does not support his view. Furthermore, young flukes have been found in February, pointing to an infection in January. Nevertheless, the general rule will hold true that in a temperate climate the time of greatest danger of infection is during the summer and early fall.

That the danger of infection gradually decreases in the fall and winter is shown by the interesting observation of Thomas that in winter the rediae produce other rediae instead of cercariae, and that fluke disease is more fatal to snails than to mammals, so that as the season advances the number of cercariae in the fields must reach its maximum and then gradually decrease.

In a warm and moist climate the conditions favorable to infection will naturally persist longer than in a cold and dry climate.

Source of infection.—The snails¹ which form the intermediate host of this parasite must, because of the transmission of fluke disease, be included among the worst enemies of the stock raiser.



FIG. 19.—*Limnaea peregra*, natural size and enlarged. (After Leuckart.)

¹ For a more detailed account, see Stiles, 1894-95, pp. 303-313.

Leuckart and Thomas experimentally demonstrated the truth of Weinland's view, that in Europe the intermediate host for this fluke is a small swamp snail (*Limnaea truncatula*). Leuckart also showed that the rediae (but not the cercariae) would develop in the young of another species of snail (*L. peregra*), and quite recently Lutz (1892 and 1893) has shown that in Oahu and Kauai (Sandwich Islands) two other snails may serve in this capacity (*L. oahuensis* Souleyet and *L. rubella* Lea). In the case of *L. oahuensis*, Lutz states that "the infection can take place only in young specimens." None of these four very closely allied species are recorded for America, and yet we find *F. hepatica* in both North America and South America, so that we must either have on this continent some other species of snail which may act as intermediate host, or some of the species described in America must be identical with some of the above-named forms.

The forms which would especially fall under suspicion are *L. humilis* Say, in North America, and *L. viator* Orb., in South America.



FIG. 21.—*Limnaea oahuensis*, natural size and enlarged. (After Souleyet.)

that is a matter for conchologists to decide. Suffice it to say that specialists in conchology have described snails under these names; that the forms are all so very closely related that a zoologist would not commit a very grave offense against systematic zoology if he were to consider them as varieties of two or three species; that the forms described under the names *L. truncatula*, *L. oahuensis*, and *L. rubella* are known to serve as intermediate hosts for the parasite now under discussion; that in Europe the rediae (but not the cercariae) develop in *L. peregra*, and that it is probable, though not demonstrated as yet, that *L. humilis* is intermediate host for North America and *L. viator* for South America.

Treatment.—Hygiene must play a much more important rôle in the treatment of this disease than therapeutics, for while the knowledge of the life history of the parasite shows us how we may to a certain extent prevent the disease, no drug is known which can be relied upon to kill the flukes or dislodge them from their habitat. A great many drugs have been tried in the hope of accomplishing this end, but although some authors recommend the use of anthelmintics, most writers admit that such drugs are practically useless in this disease,

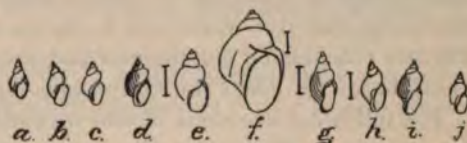


FIG. 20.—*Limnaea humilis*, natural size and enlarged. (After Binney.)

This report is not the place to discuss the question as to whether these forms (*L. truncatula*, *L. peregra*, *L. oahuensis*, *L. rubella*, *L. humilis*, and *L. viator*) represent six well-established species or not, as



FIG. 22.—*Limnaea viator*, natural size and enlarged. (After d'Orbigny.)

and that the only treatment practicable is to use stimulants and tonics (various iron salts, walnut leaves, pepper in alcoholic drinks, calamus, etc.), with good nourishing food, such as lupine seeds, lupine hay, roasted malt, linseed cakes, oats, bran, etc., rich in protein, in order to build up the system and carry the animal through to the fourth stage of the disease, when the flukes will die or, as some authorities state, wander out spontaneously; and, in case the pathological lesions are not too great, the live stock will have an opportunity to recover. Many authors recommend astringents and diuretics (salt, juniper berries, turpentine, etc.) to meet the hydropic complications.

The following are some of the formulæ given by various authors for fascioliasis in sheep, and the same medicaments may be used for this disease in cattle:

(1) The following is advised by Delafond. Make into a paste with water and allow to ferment, then bake in an oven. Give morning and evening. In about fifteen days this bread is said to produce improvement.

Mixture.	Metric.	Approximate equivalents.		
		Avoirdupois.	Apothecaries'.	Imperial troy.
Undressed wheat meal.	1 kilogram.	2½ pounds.....	2.7 pounds.....	2.7 pounds.
Oatmeal	2 kilograms.	4½ pounds.....	5.3 pounds.....	5.3 pounds.
Barley meal	1 kilogram.	2½ pounds.....	2.7 pounds.....	2.7 pounds.
Sulphate of iron....	30 grams....	1 ounce 25 grains ..	463 grains.....	463 grains.
Carbonate of soda....	30 grams....	1 ounce 25 grains ..	463 grains.....	463 grains.
Table salt	200 grams....	7 ounces 24 grains ..	3,086 grains=6½ ounces.	3,086 grains=6½ ounces.

(2) The following is Hauber's lick for 100 sheep:

Mixture.	Metric.	Approximate equivalents.		
		Avoirdupois.	Apothecaries'.	Imperial troy.
Sulphate of iron.....	60 grams....	2 ounces 50 grains ..	926 grains=1.7 ounces.	926 grains=1.7 ounces.
Calamus root	500 grams....	17 ounces 279 grains.	7,716 grains=1 pound 4 ounces.	7,716 grains=1 pound 4 ounces.
Crushed oats	20 liters	21½ quarts, U. S.	21½ quarts, U. S.	17½ quarts, imperial.
Roasted barley malt ..	20 liters	21½ quarts, U. S.	21½ quarts, U. S.	17½ quarts, imperial.

(3) The following is Hauber's lick for 50 sheep:

Mixture.	Metric.	Approximate equivalents.		
		Avoirdupois.	Apothecaries'.	Imperial troy.
Sulphate of iron...	30 grams.	1 ounce 25 grains ..	463 grains	463 grains.
Powdered juniper berries.	500 grams.	17 ounces 279 grains.	7,716 grains=1 pound 4 ounces.	7,716 grains=1 pound 4 ounces.
Gentian.....	500 grams.	17 ounces 279 grains.	7,716 grains=1 pound 4 ounces.	7,716 grains=1 pound 4 ounces.
Grits	20 liters....	21½ quarts, U. S.	21½ quarts, U. S.	17½ quarts, imperial.

(4) The following lick for 300 sheep is highly indorsed by some authors, but not considered of much value by Zürn. A portion of this

mixture is given every other day for awhile, and then once every fourteen days through the summer.

Mixture.	Metric.	Approximate equivalents.	
		U. S. apothecaries', or wine measure.	Imperial troy.
Powdered lime	5 liters	5½ quarts	4½ quarts.
Powdered table salt.....	10 liters	10½ quarts	8½ quarts.

(5) Mojkowski reports good results in treating sheep twice a day for a week with 0.7 to 1 gram (metric) of naphthaline (= 7.7 to 15½ grains apothecaries' or imperial troy).

(6) Zürn suggests the following to be mixed and given to cattle in four doses in two days:

Mixture.	Metric.	Approximate equivalents.		
		Avoirdupois.	Apothecaries'.	Imperial troy.
Powdered wormwood..	90 grams..	3 ounces 76 grains..	1,389 grains = 2.89 ounces.	1,389 grains = 2.89 ounces.
Powdered calamus root	90 grams..	3 ounces 76 grains..	1,389 grains = 2.89 ounces.	1,389 grains = 2.89 ounces.
Sulphate of iron	15 grams..	½ ounce.....	231.5 grains.....	231.5 grains.

(7) Bunk advises 30 to 60 grams (= 1 ounce 25 grains to 2 ounces 50 grains avoirdupois = 463 to 926 grains apothecaries' or imperial troy) of benzine as a daily dose for each steer, to be given in mash.

The butcher's knife will be found a much more practicable means of treatment than any of the prescriptions given above, and the earlier in the disease that the animals are slaughtered the better condition they will be found in. In the early stages of the malady, as was seen above, there is a tendency on the part of the animals to fatten, due possibly to the increased flow of bile and the consequent acceleration in digestion, and, according to several authors, this fact has been taken advantage of by certain sheep dealers who have purposely exposed their flocks to fluke infection in order to fatten them early in the season.

In the case of cattle infected with *F. hepatica* it will scarcely be necessary to take such strenuous precautions as with sheep, for, as already stated, the disease is by no means as fatal to cattle as to sheep; in fact, in the vast majority of cases the presence of the parasites in cattle is not recognized until after the animals are slaughtered. This must not, however, be interpreted as meaning that the disease in cattle may be ignored, but merely that the disease in sheep must receive much more prompt attention than the disease in cattle.

If sheep are pastured in the same region as cattle, the presence of this parasite in cattle becomes doubly important, for in this case the disease will be spread to sheep and may cause heavy losses. Prompt measures to suppress the disease and isolation of the infested cattle should accordingly be resorted to.

Preventive measures.—For an excellent and more detailed account of the preventive measures, the reader is referred to Thomas (1883, pp. 296–305), of which the greater part of the following is a summary:

As seen from the life history of the parasite, four conditions are necessary for the propagation of this disease in any given district, namely: (1) The presence of fluke eggs; (2) wet ground, or water during the warmer weather, in which the eggs may hatch; (3) a snail (*L. truncatula*, or certain other species) which will serve as intermediate host; (4) herbivorous animals must be allowed to feed upon the infected pastures without proper precaution being taken to prevent infection. Destroy any one of these conditions and fluke disease will be destroyed; control any one of these conditions and the disease will be controlled in equal measure.

These conditions may be controlled or held in check by the following means:

(1) *To prevent the scattering of eggs in the fields:*

(a) In buying cattle or sheep, do not purchase any from a fluky herd, as they may introduce the disease to your farm.

(b) If animals are fluked, send those which are most affected to the butcher and place the others on dry ground.

(c) Destroy the livers of the slaughtered fluked animals, or if used as food for animals (dogs, etc.), they should first be cooked in order to kill the eggs; if this precaution is not taken, the fresh eggs will pass through the intestine of the dogs uninjured and be scattered over fields.

(d) Manure of fluky animals should never be placed upon wet ground. It is, however, not dangerous to use such manure upon dry ground.

(e) "As rabbits and hares may introduce the disease into a district, or may keep up an infection if once introduced, these animals should be kept down as much as possible." This is not always practicable.

(f) Where animals very heavily infested with flukes have pastured on a given piece of ground, some one should go over the field with a spade and spread out the patches of manure, so that it will dry more rapidly, and thus the eggs may be more quickly destroyed. A spade full of lime or dust will aid in drying up the manure patches.

(g) Manure of fluky animals should not be stored where it can drain into pastures.

(2) *To control the second condition, i. e., marshy ground:*

(a) The marshes should be drained, if possible, so that the snails may be gotten rid of.

(b) It has been noticed that sheep which pasture on salty marshes are not fluked; accordingly dressings of salt, to which lime may be added, should be spread over the pasture, as salt and lime will destroy the embryos, the encysted cercariae, and the snails. May to August are the best months for scattering these substances.

Lime will destroy the grass for immediate use, but will in some cases be advantageous to the soil. The farmer must decide for himself whether he should use salt alone or lime and salt.

(c) If the marshy ground can not be controlled, place the animals on higher ground.

(3) *To destroy the snail.*—This may be done by draining the fields, thus depriving the snails of the conditions necessary for their development, or by the free use of salt and lime.

(4) *General precautions to be taken:*

(a) It is known that salt will kill the cercariae; accordingly if salt is given to the animals they stand a better chance of escaping hepatic infection, even if the germs are swallowed, not only because this substance kills the young flukes, but because it aids the animals in their digestion. The following experiment is interesting in this connection:

A number of uninfected sheep were selected and divided into two flocks, then placed upon pasturage which was known to be infected. One flock received no special attention, while the sheep of the other flock were fed a quarter of an ounce of common salt well mixed with half a pint of oats every day that they were on the pastures; but when fed upon turnips, vetches, etc., the allowance of salt and corn [= oats] was not given. The first flock were so infected with flukes that they could not be kept through the winter, while the second flock was quite sound. The corn [= oats] and salt had cost about 3s. (75 cents) per head; the profit was about 50s. (\$12.50) per head.—T. P. HEATH, *Western Morning News*, October 14, 1882.

(b) A daily allowance of dry food should be given.

(c) If fields are overstocked the animals will be obliged to graze very close to the ground, and will thus be more liable to become infected; accordingly, in order to prevent this close grazing, fields should not be overstocked.

(d) Animals should not be left too long upon the same pasture.

(e) Raised watertanks should be placed in the pastures so that the herds will not be forced to drink from pools, etc. As it is difficult for snails to get into such drinking tanks, there will be little fear of infections from tanks of this sort.

ABATTOIR INSPECTION.

Fluked animals as food.—If only a few flukes are found in the liver and these have not caused any extensive pathological changes, there seems to be no valid reason for condemning the entire organ as food, for the eggs would be perfectly harmless if eaten; the adult parasites, if swallowed alive, might cause some temporary injury, but as liver is well cooked in this country, there is scarcely any chance that the adult worm would be swallowed alive; if the pathological change is confined to a portion of the liver, that portion can be cut out and the rest may be used for food; in case of a general cirrhosis, or in case of suppurating inflammation of the tissue, caused by the wandering of flukes through the same, the liver should be condemned to the tank. There is generally no particular alteration to be noticed in the flesh of fluked cattle, unless the livers are very far gone, in which case the meat is more "flabby" and lighter than usual. In the case of badly fluked sheep, the flesh is of a very poor quality and contains but little nour-

ishment; it is pale and "flabby," and according to European authors it should not be placed on the market in case the sheep have passed Gerlach's second stage of the disease.

JURISPRUDENCE.

In this country we have no general laws protecting a person in case he buys fluked animals. In Germany, Austria, and Switzerland certain laws protect the buyer, so that if fluke disease shows itself in a flock within a stated time after purchase the contract is void.

THE COMMON LIVER FLUKE IN MAN.

This parasite is rare in man, only about twenty cases being on record of its presence in the bile ducts. It is not at all impossible that the parasites described as *Hexathyridium venarum*, *Distomum oculi-humani* (*D. ophthalmobium*), and *Monostomum lentis* are young erratic liver flukes.

The fluke may produce serious trouble in man, which may result fatally.

VARIETIES OF THE COMMON LIVER FLUKE.

Several varieties of the Common Liver Fluke have been described by different authors, and although they have not yet been recorded in this country, they should be mentioned briefly in this report:

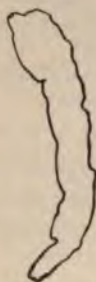


FIG. 23.—The Narrow Liver Fluke (*Fasciola hepatica angusta*), natural size (original, from one of the cotypic specimens).

(a) THE NARROW LIVER FLUKE (*Fasciola hepatica angusta*) OF SENEGAL CATTLE AND MAN (?).

[Figs. 23 and 24.]

This variety has recently been described by Railliet (1895, p. 338) from specimens taken from cattle slaughtered at St. Louis, Senegal. Blanchard (1895, p. 733) thinks it identical with *Fasciola gigantica* (see p. 49) of the giraffe. He also considers it identical with a parasite expectorated by a French naval officer in Brazil and recorded by Gouvea (1895). See also the next variety.

(b) THE EGYPTIAN LIVER FLUKE (*Fasciola hepatica aegyptiaca*) OF BUFFALO AND CATTLE.

[Figs. 25 and 26.]

This parasite was originally described by Looss (1896, pp. 33-36, 192) as a variety of the common fluke, but he has recently written to us that he is now inclined to look upon it as a distinct species. He found the parasite in the liver of cattle (*Bos taurus*) and buffalo (*Bos bubalis*). Blanchard (1896, p. 733) evidently considers this form identical with both the narrow fluke (*F. hepatica angusta*) and the giant fluke (*F. gigantica*, p. 49).

(c) THE COMMON LIVER FLUKE (*Fasciola hepatica caviae*) OF GUINEA PIGS.

SYNONYMY.—*Distomum caviae* Sonsino, 1890; *Fasciola hepatica* var. *caviae* (Sonsino) Sonsino, 1896.

Sonsino described this parasite from the guinea pig as a distinct species, but he now believes it to be a variety of the Common Liver Fluke.



FIG. 24.—The Narrow Liver Fluke (*Fasciola hepatica angusta*), enlarged to show the anatomical characters: a, acetabulum; i, intestine m, mouth with oral sucker; o, ovary; p, pharyngeal bulb; s, shell gland; t, profusely branched testicles; u, uterus; va, vagina; vg, profusely branched vitellogene glands. See p. 48.

3. The Giant Liver Fluke (*Fasciola gigantica*) of Giraffes, Cattle (?), and Man (?).

[Fig. 27.]

SYNONYMY.—*Fasciola gigantica* Cobbold, 1856; *Distomum giganteum* Diesing, 1858; *Distoma hepaticum* ex p. of Gervais and van Beneden, 1858; *Fasciola gigantea* Cobbold, 1859; *Cladocœlium giganteum* (Diesing) Stossich, 1892 ex. p.

BIBLIOGRAPHY.—For bibliography and technical discussion, see Stiles, 1894-95, pp. 139-143.

HOST.—Giraffe, cattle (?), and man (?). (See pp. 137-143.)

This parasite was described from specimens taken in England from a giraffe belonging to a traveling menagerie. Blanchard (1895, p. 733) believes it identical with the narrow fluke (p. 48) and evidently also with the Egyptian fluke (p. 48).

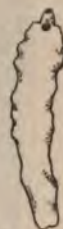


FIG. 25.—The Egyptian Liver Fluke (*Fasciola hepatica aegyptiaca*), drawn from one of Looss' specimens, natural size (original). See p. 48.

4. The Large American Fluke (*Fasciola magna*) of Cattle and Deer.

[Figs. 28-35].

For anatomical characters, compare figs. 29 and 30 with key, p. 21.

VERNACULAR NAMES.—English, *The Large American Fluke*, *The Grand Fluke*; German, *Der grosse amerikanische Leberegel*; French, *Grand Distome*; Italian, *Distoma grande*, *Distoma magno*.

SYNONYMY.—*Distomum magnum* Bassi, 1875; *Fasciola carnosus* Hassall, 1891; *F. americana* Hassall, 1891;



FIG. 26.—The Egyptian Liver Fluke (*Fasciola hepatica aegyptiaca*), enlarged to show the anatomical characters: *a*, acetabulum; *c*, cirrus pouch; *i*, intestine; *m*, mouth with oral sucker; *o*, ovary; *s*, shell gland; *t*, profusely branched testicles; *ut*, uterus; *va*, vagina; *vg*, profusely branched vitellogene glands. (After Looss, 1896, Pl. III, fig. 16.) See p. 48.



FIG. 27.—The Giant Liver Fluke (*Fasciola gigantica*), enlarged to show the anatomy. (After Cobbold, 1864.) See p. 49.

Distomum texanicum Francis, 1891; *D. americanum* (Hassall) Stiles, 1892; *Fasciola magna* (Bassi) Stiles, 1894.

BIBLIOGRAPHY.—For bibliography and technical discussion, see Stiles (1894-1895).
HOSTS.—Cattle, deer, and other animals. (See pp. 137-143.)

GEOGRAPHICAL DISTRIBUTION.—North America (Texas, Arkansas, Indian Territory, California, Iowa, Illinois, New York, and probably elsewhere); Europe (Italy).

The Large American Fluke appears to be more frequent in this country than the so-called Common Liver Fluke, although this opinion is the result of general impression from abattoir inspection rather than a view based upon actual statistics. The parasite was first described by Bassi, who found it producing a fatal epizootic among the deer of the Royal Park near Turin, Italy, where it is supposed to have been introduced with imported Wapiti from North America. Dinwiddie has found that in some counties of Arkansas practically all the cattle are infected

with this worm, and for years the livers of cattle from certain districts have been unfit for use. As the infected area fell within the cattle-fever district, some persons erroneously thought that the changes produced in the liver were due to Texas fever. Fortunately this species (so far as known) does not occur in sheep, and on that account it must be looked upon as of less importance than the common fluke.

Leidy (1891) thought this species identical with "*Distomum crassum*," which occurs in man, and Stossich (1892) considered it identical with the giant fluke *Cladocoelium giganteum* (= *Fasciola gigantica*) of giraffes.

Life history.—The complete life history of this parasite has not yet been experimentally demonstrated, but as the species is so closely allied to the Common Liver Fluke, it will unquestionably be found that the life cycle agrees with that given for *Fasciola hepatica* (p. 30).

Upon several different occasions experiments have been instituted in this Bureau to trace out the life cycle, but the snails we have collected



FIG. 28.—The Large American Fluke (*Fasciola magna*), natural size (original).

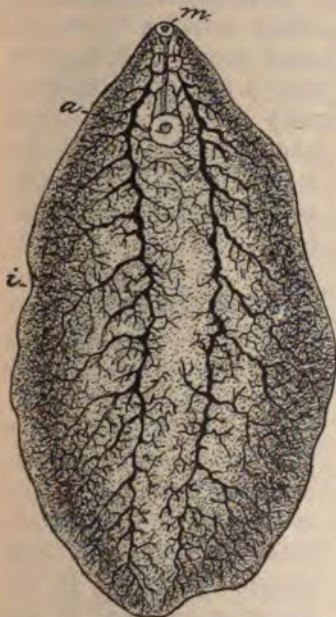


FIG. 29.—Macerated specimen of Large American Fluke, showing the digestive system and acetabulum. $\times 2$. (After Stiles, 1894, p. 226, fig. 2.)

in the locality of the District of Columbia have thus far not taken the infection.

Egg.—The eggs (fig. 32) of *F. magna* can hardly be distinguished from those of *F. hepatica*. In general, however, they are slightly larger. In *F. hepatica* they vary from 0.105 mm. to 0.145 mm. (rarely 0.172 mm.) long by 0.063 mm. to 0.09 mm. broad. In *F. magna* they vary from

0.109 mm. to 0.168 mm. long by 0.075 mm. to 0.096 mm. broad. The structure of the egg agrees perfectly with that given for the Common Liver Fluke, so that a differential diagnosis in faecal examinations is impossible. Upon several different occasions we have raised the —

Miracidium (figs. 33, 34), which agrees with the ciliated embryo of *F. hepatica* (see p. 32). It is covered with a ciliated epithelium, and upon its anterior end is found a papilla in which an opening is perfectly visible. This opening leads into a thin string of tissue, evidently a rudimentary oesophagus, ending in a double-lobed body, which from homology with *F. hepatica* represents the rudimentary intestine. Immediately anterior of this is situated the ganglionic mass with the two cup-shaped eye-spots. In the posterior portion of the body a number of germ

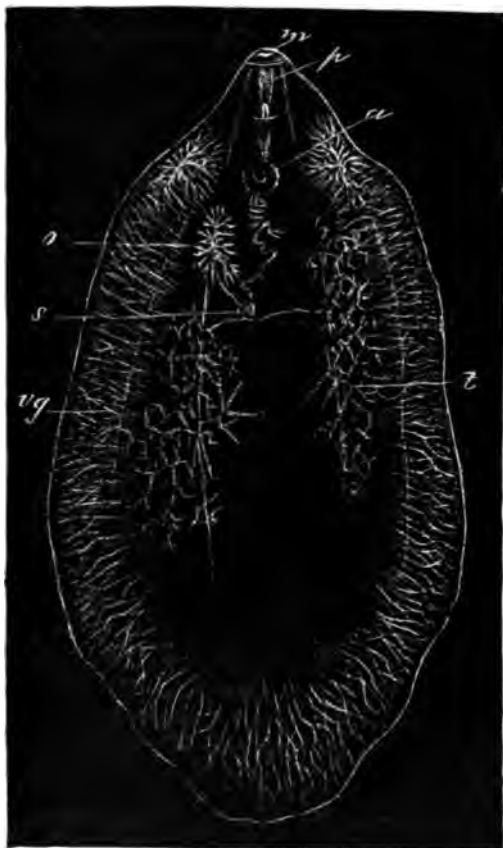


FIG. 30.—Macerated specimen of Large American Fluke (*Fasciola magna*), showing the anatomical characters: a, acetabulum; m, mouth with oral sucker; o, ovary; p, pharyngeal bulb; s, shell gland; t, profusely branched testicles; vg, profusely branched vitellogene glands. $\times 2$. (After Stiles, 1894, p. 236, fig. 3.)

cells can be distinguished. The movements of this embryo agree with those of *F. hepatica*. The size varies according to contraction, but in general it may be given as 0.15 mm. long by 0.04 mm. broad.

Sporocyst, redia, and cercaria.—For a description of these stages (not yet known for *F. magna*), see pp. 32 and 33.

The disease.—The remarks upon this subject on page 36, under *F. hepatica*, will apply in a general way to this parasite also. The large

fluke appears to be more dangerous for cattle, however, than the common fluke. According to Francis, many cattle die from the effects of the common fluke, and those which recover do not thrive the following summer, but remain poor and weak and fail to breed—remarks which if well founded for *F. hepatica* would apply in a still greater degree for *F. magna*. Heifers coming 2 years old suffered more than at any other age. It is stated that the large fluke has caused disease among the dairy cows in California, and Francis is said to have investigated an outbreak in Texas where the loss ran into hundreds of cattle. In the Italian outbreak, the disease corresponded with fluke disease of sheep, and reached its highest stage during the winter and spring. Bitting (1895) records fluke disease in cattle for Florida, but attributes it to the common fluke.

Symptoms.—See remarks under *F. hepatica*, pp. 34-36.

Pathology.—The pathological changes brought about by this form have never been studied in detail, but

the earlier changes will doubtless agree with those described for *F. hepatica*. In heavily infected livers there is a much greater tendency to the formation of large cysts in the liver, in which several parasites are present. Dinwiddie has described a post-mortem as follows:

Apparently in good health and fair butchering condition. The "fat caul" seen on first opening the abdomen as a large sheet was dotted with black spots and streaks. Lymphatic glands on the concave surface of the liver were much swollen and black in color. The liver itself was enlarged and darkened on the surface, with a number of prominent elevations, some appearing like blisters and some more or less solid, and varying greatly in size. A longitudinal section showed the presence of many cavities, some containing a dark fluid in which were floating granules and shreds of tissue. One very large cavity, about 2 inches in diameter, with irregular yellowish colored walls, besides the dark-colored fluid above mentioned, contained also two flat, leaf-like bodies about one inch in length and slightly less in breadth. They were fished out and recognized as "flukes." More of these were obtained from other cavities. Several other cavities contained solid, greenish-yellow, gritty matter, and no parasites. A section made through the liver in any direction cut through one or more of these cysts. They were situated near the surface of the organ or in its substance indiscriminately. Those that contained the "fluke" were usually of medium or smaller size, and the parasite was found folded or curled upon itself longitudinally and surrounded by fluid. * * *

The shreds of tissue found in



FIG. 31.—A section of the cuticle of Large American Fluke (*Fasciola magna*), showing the spines. (After Stiles, 1894, p. 227, fig. 7.)



FIG. 32.—Egg of Large American Fluke, showing the germ cell, surrounded by a large number of vitelline cells, and an eggshell provided with a cap. (After Stiles, 1894, p. 227, fig. 4.)



FIG. 33.—Ciliated embryo (miracidium) of Large American Fluke within the eggshell. (After Stiles, 1894, p. 227, fig. 5.)

those cysts, which did not contain the living parasites, were shown by microscopic examination to be the débris of dead and partly decomposed flukes.

Such were the gross appearances of the livers of at least three-fourths of the cattle slaughtered during the spring and summer at this place, and about 90 per cent of all coming from certain ranges in St. Francis and Lee counties [Arkansas].



FIG. 34.—Free embryo (miracidium) of Large American Fluke (*Fasciola magna*), showing ciliated epithelium, boring papilla, rudimentary oesophagus, and intestine; eye-spots situated above the ganglionic mass, and germ cells. (After Stiles, 1894, p. 227, fig. 6.)

I am inclined to think that the effects of the parasite upon cattle have possibly been somewhat overestimated, for I have seen cattle in abattoirs which were apparently in excellent condition and yet whose livers were literally composed almost entirely of flukes and their cysts. The question arises whether other factors (Texas fever, blackleg, etc.) also were not concerned in the outbreaks among cattle which have been attributed to this parasite. A small number of these worms certainly has little or no appreciable effect upon cattle, and even when a large number is present the effects do not appear to be very great in the case of full-grown steers. The fact that Francis has attributed the death of a number of cattle (chiefly 2-year-olds) to this worm is deserving of attention, but the published accounts of these outbreaks are not detailed enough to allow a satisfactory conclusion. While it must be admitted that the pathological changes in the liver of cattle caused by this parasite can not help producing some effect upon the host, we are perfectly warranted in the statement that the Large American Fluke bears a much less important relation to the cattle industry than the common fluke bears to the sheep industry.

Diagnosis.—Same as for the common fluke. (See p. 39.)

Position of the parasites.—Thus far the large fluke has been recorded only in the liver and lungs.

Influence of age.—The remarks on page 40 under this heading will doubtless be found to hold for the large fluke also.



FIG. 35.—Cyst in the liver, caused by Large American Fluke. (After Stiles, 1894, p. 226, fig. 1.)

Geographical distribution; fluky years and fluky seasons.—*F. magna* is known from the localities given on page 51. (See also remarks under this head in the discussion of *F. hepatica*, p. 40.)

Time of infection.—The remarks under this head on page 42 will apply in a general way to this parasite also.

Source of infection.—The intermediate host is as yet

unknown, but it should not be a difficult matter to determine this point in the infected areas. It will undoubtedly be found to be a snail, probably of the genus *Limnaea*.

Treatment and preventive measures.—See pages 43–47.

ABATTOIR INSPECTION.

Fluked animals as food.—Regarding the flukes in the liver, see page 47. I have examined the meat of a large number of cattle whose livers were infested with this parasite, and have been unable to find any ground for excluding the meat from market. (See also pp. 47–48.)

DICROCOELES (Distomes of the Genus Dicrocoelium).

One representative of this genus, namely, *D. lanceatum*, has been recorded for cattle, sheep, and hogs, and a second species (*D. pancreaticum*) has been recorded for cattle and sheep, but there is no satisfactory evidence that either parasite is present in this country. (See p. 56.)

5. The Lancet Fluke (*Dicrocoelium lanceatum*) of Cattle, Sheep, and Swine.

[Figs. 36–39.]

FIG. 37.—Lancet Fluke, enlarged to show the anatomical characters: *a*, acetabulum; *c*, cirrus pouch; *i*, intestine; *m*, mouth with oral sucker; *o*, ovary; *oe*, oesophagus; *p*, pharyngeal bulb; *t*, lobate testicles; *u*, uterus; *va*, vagina; *vg*, vitellogene glands. (After Stiles & Hassall, 1894, PL. IV, fig. 19.)

Dujardin, 1845; "*Distomum lanceolatum* Mehlis" of Diesing, 1850; "*Dicrocoelium lanceolatum* Dujardin" of Weinland, 1858; "*Fasciola Buchholzii* Jördens, 1801," misprint of Braun, 1889; *Dicrocoelium lanceatum* Stiles & Hassall, 1896.

FIG. 36.—Lancet Fluke (*Dicrocoelium lanceatum*), natural size (original).



For anatomical characters, compare fig. 37 with key, p. 21.

VERNACULAR NAMES.—English, *Lancet Fluke*; German, *Der lanzettförmige Leberegel, das lanzettförmige Doppelloch*; French, *Distome lanceolé*; Italian, *Distoma lanceolato*.

SYNONYMY.—*Fasciola lanceolata* Rudolphi, 1803 [nec Schrank, 1790]; *Distoma lanceolatum* (Rudolphi) Mehlis, 1825; "*Distoma* (*Dicrocoelium*) *lanceolatum* Mehlis" of

BIBLIOGRAPHY.—No extensive bibliography as yet published. For detailed technical discussion, see Leuckart (1889, pp. 359-399).

HOSTS.—Man, cattle, sheep, swine, and other animals. (See pp. 137-143.)

GEOGRAPHICAL DISTRIBUTION.—Very extended, especially in Europe, but apparently not in England or North America.

Life history.—The complete development of this parasite is not yet known, although it is undoubtedly an indirect development with change of host, the intermediate host being some mollusk.

Von Willemoes-Suhm looked upon *Planorbis marginatus* as intermediate host; a *Limnaea* has also been viewed with suspicion.

Leuckart found some cercariae in a *Planorbis*, which he suspected for a while represented the larval stage of this worm; but as none of these snails have as yet been experimentally proven to be

FIG. 38.—Egg of Lancet Fluke (*Dicrocoelium lanceatum*) with contained embryo. $\times 700$. (After Leuckart, 1889, p. 379, fig. 171.)

the host of the larval stage of the parasite, the question is at present far from being solved. In Leuckart's most recent experiments he has fed eggs of the parasite to certain small slugs and noticed that the embryos escaped from the egg, but were unable to develop



FIG. 39.—Free embryo (miracidium) of the Lancet Fluke: A, lateral view; B, dorsal view. (After Leuckart, 1889, p. 385, fig. 175 A, B.)

into the sporocyst stage. That the embryos escaped from the eggshell in the intestine of slugs points to the fact that the experiments are in the right direction, and that it will probably be found that some snail belonging to the family Limacidae—the slugs—in the order of the Pulmonata serves as intermediate host to the Lancet Fluke.

The Lancet Fluke is much less dangerous, owing to its smaller size and unarmed cuticle, than either the common fluke or the large fluke; and the pathological changes caused by the Lancet Fluke, even when present in large numbers, are scarcely ever more than a catarrhal affection of the gall ducts, rarely with secondary troubles. The parasite is frequently found in very large numbers, cases being recorded where 1,000 specimens or more have been taken from a single liver; it may occur alone or in company with *F. hepatica*. It has been recorded about six times in man.

Leidy (1856, p. 43) says that this parasite is "stated to be frequent in sheep in several of the Western States." This



FIG. 40.—The Pancreatic Fluke (*Dicrocoelium pancreaticum*), enlarged to show the anatomical characters: a, acetabulum (c, cirrus pouch; ep, excretory pore; i, intestine; m, mouth with oral sucker; ov, ovary; ph, pharyngeal bulb; t, testicles; u, uterus; va, vagina; vg, vitellogene glands. (After Railliet, 1897.) See p. 57.

"statement" may be correct, but we have not yet been able to verify it.

ABATTOIR INSPECTION.

In abattoir inspection, the rules given for infection with *F. hepatica* (p. 47) would apply to cases of infection with the Lancet Fluke.

6. The Pancreatic Fluke (*Dicrocoelium pancreaticum*) of Cattle and Sheep.

[Fig. 40.]

For anatomical characters, see key, p. 21.

SYNONYMY.—*Distoma pancreaticum* Railliet, 1890; *Distoma coelomaticum* Giard & Billet, 1892; *Distomum pancreaticum* Janson, 1893; *Distoma (Dicrocoelium) coelomaticum* Giard & Billet of Railliet, 1896; *Dicrocoelium pancreaticum* (Railliet) Railliet, 1897.

BIBLIOGRAPHY.—Railliet, 1897, pp. 371-377.

HOSTS.—Japanese cattle and sheep, Cambodia cattle and Indian buffalo. (See pp. 137-143.)

The Pancreatic Fluke, which is somewhat smaller than the common fluke but larger than the Lancet Fluke, has been found in Japan, Tonkin, and Cochin China, but is not yet recorded for North America; it is said to be present in about 50 per cent of the cattle and buffaloes of Cochin China, slaughtered in good condition, and in 90 per cent of the cachectic animals; it is found at all seasons of the year, both wet and dry. Its normal seat is the Ductus Wirsgianus and its branches, which are occasionally given a sausage-like appearance by the presence of the parasites. The local lesions developed by the presence of the Pancreatic Fluke are not generally very extensive; in many cases the pancreas seems quite normal; when the infection is

extensive, however, this organ is thicker and heavier than usual; occasionally blackish streaks are noticed on the surface, representing the infected canals, but usually it is necessary to cut into the organ in order to recognize an infection. Even when the infected canals assume a sausage-like or moniliform appearance, no abnormal fluid appears to be present, and the thickening and induration of the walls are scarcely noticeable.



FIG. 41.—Male and female specimens of the Human Blood Fluke (*Schistosoma haematobium*), enlarged. $\times 12$. (After Looss, 1896, Pl. XI, fig. 107.) See p. 58.

There is at present no reason to assume that these parasites would continue to live for any length of time if accidentally eaten by man; in fact, their direct transmission from cattle to man through eating sweetbreads infected by them is contrary to analogy.

Dioecious Distomes (Flukes of the Subfamily *Schistosominae*).

BLOOD FLUKES (Distomes of the Genus *Schistosoma*).

Flukes of this genus, only a few of which are known, live in the veins of mammals and birds. At least one species (*S. bovis*) is found in cattle and sheep, while the occurrence of a second form (*S. haematobium*) in cattle is as yet in need of confirmation.

The Human Blood Fluke has been found twice in this country: once in a foreigner on the "Midway" during the World's Fair, and once in New York.

7. The Human Blood Fluke (*Schistosoma haematobium*) of Man and Cattle (?).

[Figs. 41-44, 48.]

For anatomical characters, compare figs. 41-43 with key, p. 21.

SYNONYMY.—*Distomum haematobium* Bilharz, 1852; *Schistosoma haematobium* (Bilharz) Weinland, 1858; *Gynaecophorus haematobius* (Bilharz) Diesing, 1858; *Bilharzia haematobia* (Bilharz) Cobbold, 1859; (?) *Bilharzia magna* Cobbold, 1859; *Thecosoma haematobium* (Bilharz) Moquin-Tandon, 1860; *Distoma capense* Harley, 1864, nomen nudum; *Bilharzia capensis* Harley, 1864; *Bilharzia haematobia hominis* Kowalewski, 1895; (?) *Bilharzia haematobia magna* (Cobbold) Kowalewski, 1895; *Schistosomum haematobium* (Bilharz) of Blanchard, 1895.

BIBLIOGRAPHY.—For bibliography, see Huber (1894, pp. 294-305). For detailed anatomical study, see Looss (1895, pp. 1-108) and Leuckart (1894, pp. 464-534).

HOSTS.—Man, Sooty monkey (?), and cattle (?). (See pp. 137-143.)

GEOGRAPHICAL DISTRIBUTION.—Africa.

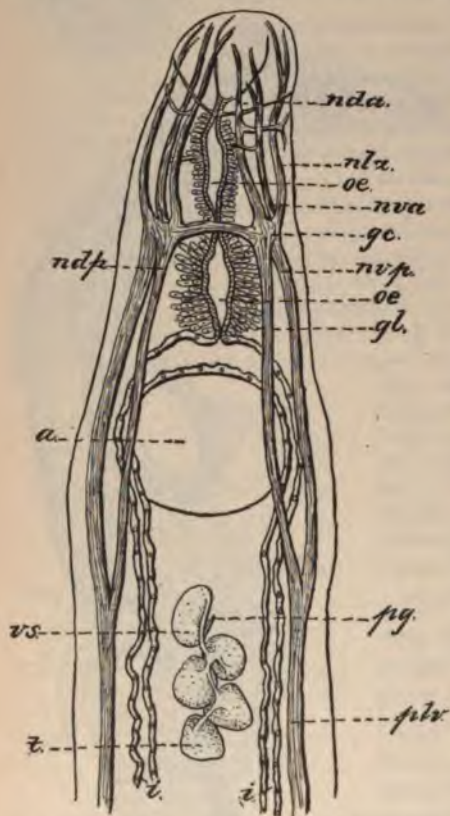


FIG. 42.—Anterior portion of male Human Blood Fluke (*Schistosoma haematobium*), showing the anatomical characters: a, acetabulum; gc, cerebral ganglion; gl, glands of oesophagus (oe); t, intestine; nda, dorsal anterior nerve; ndp, dorsal posterior nerve; nla, lateral anterior nerve; nva, ventral anterior nerve; nvp, ventral posterior nerve; pg, genital pore; t, testicles; vs, vesicula seminalis. (After Looss, 1895, Pl. II, fig. 18.)

Life history.—The following may be taken as a summary of our present incomplete knowledge of the life history of this parasite. The eggs which are passed in the urine contain a ciliated embryo possessing a terminal papilla; a rudimentary intestinal sac, at each side of which

is a large glandular cell; a rudimentary nervous system; an excretory system, and a number of germinal cells. While in the fresh urine the embryo is comparatively quiet, but more active movements can be brought about by the addition of water; water also causes the shell to burst, the embryo becoming free; preserved in urine the embryos die within about two hours. From this embryonic stage to the time when the parasites are found in the body we have no positive data concerning the life history, although clinical observation and analogy point to unfiltered water as the source of infection.

Sonsino concluded from his recent investigations that fresh-water crustaceans (*Gammarus Simoni*) and insects form the intermediate hosts; that the embryo develops through a larval stage ("Dicotyle"), but without an alternation of generations, and that man becomes infected by swallowing the "Dicotyle."

While analogy points directly to some fresh-water invertebrate as the intermediate host, the presence of germ cells in the miracidium points to a necessary alternation of generations as opposed to Sonsino's idea of a metamorphosis.

Hosts.—The Human Blood Fluke is found in man in Africa, especially in Egypt. A parasite found by Cobbold in the Sooty monkey (*Cercopithecus fuliginosus*), and described as *Bilharzia magna*, may possibly be identical with this parasite of man.

Cobbold, Leuckart, and Blanchard admit the identity of the two forms, while some other authors do not consider the point as yet established.

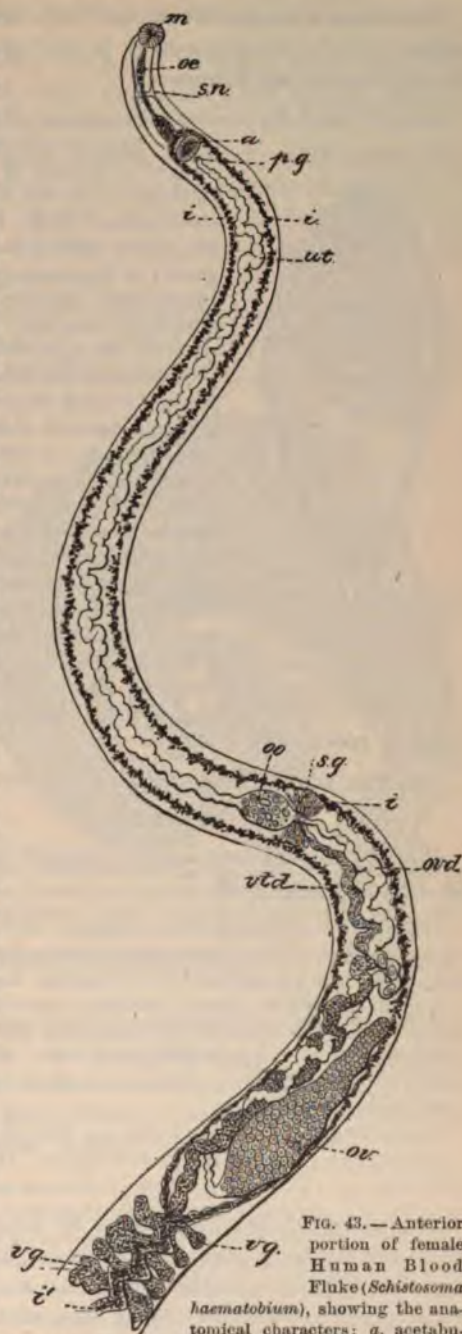


FIG. 43.—Anterior portion of female Human Blood Fluke (*Schistosoma*

haematobium), showing the anatomical characters: a, acetabulum; i, intestine which is double for some distance, but the two caeca unite (i) back of the ovary; oe, oesophagus; oo, ootyp; ov, ovary; oed, oviduct; pg, genital pore; sg, shell gland; sn, nervous system; ut, uterus; vtd, vitello duct; vg, vitellogene glands. X 38. (After Looss, 1896, Pl. XI, fig. 108.)

haematobium; i, intestine which is double for some distance, but the two caeca unite (i) back of the ovary; oe, oesophagus; oo, ootyp; ov, ovary; oed, oviduct; pg, genital pore; sg, shell gland; sn, nervous system; ut, uterus; vtd, vitello duct; vg, vitellogene glands. X 38. (After Looss, 1896, Pl. XI, fig. 108.)

Schistosoma haematobium has been recorded once from cattle in Calcutta, but the determination is perhaps open to question. The exact data given are as follows:

Bomford found the peculiar uncinatè ova of *Bilharzia* on microscopic examination



FIG. 44.—Egg of Human Blood Fluke (*Schistosoma haematobium*), with contained embryo, passed in the urine. $\times 285$. (After Looss, 1896, Pl. XI, 112.)

of the large intestines of two Calcutta transport cattle destroyed on account of their being considered affected with rinderpest. In one case numerous eggs were found in a small portion of the caecum preserved in absolute alcohol. They were most numerous within or between the tubular glands of the mucous membrane, but were also present in considerable numbers in the submucous tissue below the muscularis mucosae. The alcohol had shriveled up the contents of the eggs, but the external form of the shell was preserved and the characteristic hook very clearly seen. In another bullock the ova were found in some papillomatous growths removed from the margin of the anus. In this case the form of the embryo in the ova could be distinguished. The ova exactly resemble those of *Distomum* (*Bilharzia*) *haematobium* hitherto found only in man (or a monkey), and in Africa, Arabia, or Mauritius. Sonsino's *Bilharzia bovis* of Egyptian cattle differs in the spindle shape of its eggs and in their short, broad, caudate spine. These bullocks had not served in Egypt, but may possibly have obtained the parasites from Indian transport cattle which had done so. This parasite should be sought for in cases of Haematuria of cattle and when the ileocaecal ring is found congested. (See Mem. Med. Officers Army

India, II (1886), 1887, p. 53.)

B. The Bovine Blood Fluke (*Schistosoma bovis*) of Cattle and Sheep.

[Figs. 45-47.]

For anatomical characters, compare figs. 45 and 46 with the key, p. 21.

SYNONYMY.—*Bilharzia bovis* Sonsino, 1876; *Bilhartzia crassa* Sonsino, 1877; *Gynaecophorus crassus* (Sonsino) Stossich, 1892; *Gynaecophorus bovis* (Sonsino) Railliet, 1893; *Bilharzia haematobia crassa* (Sonsino) Kowalewski, 1895; *Schistosomum bovis* (Sonsino) R. Blanchard, 1895.

BIBLIOGRAPHY.—For bibliography, see R. Blanchard (1895, p. 191). For anatomical discussion, see Leuckart (1894, pp. 464-534).

HOSTS.—Cattle and sheep. (See pp. 137-143.)

GEOGRAPHICAL DISTRIBUTION.—Egypt, Italy, Sicily, India (?).

This parasite was discovered by Sonsino (1876) in Egypt in the portal veins of the ox and later he found it in sheep, while Grassi and Rovelli afterward found it in about 75 per cent of the sheep slaughtered at Catania, Sicily. The sheep were born and raised on the neighboring plains.

The worm is said to bring about in cattle and sheep the same lesions of the bladder, intestine, etc., which *S. haematobium* causes in man. Nothing is known regarding the life history.



FIG. 45.—The Bovine Blood Fluke (*Schistosoma bovis*), male and female. $\times 9$. (After Leuckart, 1894, p. 467, fig. 204A.)

THE DISEASE BILHARZIOSIS.

As this disease in man has been subjected to much more thorough study than the same malady in cattle and sheep, the human subject may well be taken as basis for the discussion.¹

Source of infection.—As already stated, clinical observation and analogy point to unfiltered drinking water as the source of infection.

Position of the parasite.—The worms are found in the veins of the abdomen, the vena porta, vena linealis, vena renalis, and the venous plexus of the bladder and of the rectum.

Symptoms.—The *period of incubation* has not been definitely determined, but Hatch records the case of a patient who remained fourteen days at Suez and suffered from bilharzian haematuria one month after his arrival at Bombay. The young parasites appear to do no injury; in fact, even the adult worms seem to be inoffensive in themselves. The eggs on the other hand, armed with a sharp point, are the exciting cause of the disease. The position of the parasite in the venous system and the consequent location of the agglomeration of eggs determine the particular symptoms. Either the genito-urinary system is attacked, in which case haematuria is one of the first symptoms; or the large intestine is attacked and blood is noticed in the stools.



FIG. 46.—Cross section of Bovine Blood Fluke (*Schistosoma bovis*), showing the position of the female in the gynaeophoric canal. $\times 200$. (After Leuckart, 1894, p. 472, fig. 209.)

If the parasites are lodged in the venous plexus of the genito-urinary system, the chief symptoms are: Haematuria; pains in the lumbar region, the left iliac fossa, the thigh, or in the vulva, which may be spontaneous or may accompany micturition; cystitis; vesical calculus; urinary fistulae; vaginal verminous tumors; nephritis.

The eggs accumulate in the capillaries, which they rupture; they traverse the mucosa and fall into the bladder, thus causing more or less hemorrhage; in this way the *haematuria* is established, which is often the initial symptom. At first the urine is quite bloody, but it gradually becomes clearer, and it is only at the end of micturition that muco-purulent flakes are expelled, in which numerous eggs and even embryos are found; the urine contains also epithelial cells, more or less pus, eggs, and occasionally embryos. On micturition sharp pains are felt at the base of the penis or at the gland, possibly due to the passage of eggs. The passage of eggs

¹ This discussion is based chiefly upon Blanchard, 1895, pp. 69-93.

through the walls of the bladder give rise to *cystitis*; blood becomes more abundant in the urine after fatigue, coitus, or after taking alcoholics; clots may form and cause retention of urine; chronic urethritis may develop, evidently due to the presence of the eggs. In Egypt 80 per cent of the cases of *vesical calculus* coincide with bilharziosis; the formation of the calculi evidently results from the presence of the eggs, for the central nodule always contains one or more of these structures. Urinary fistulae, opening on the perineum, more rarely into the rectum, occasionally form. In women, the vagina may become the seat of a chronic inflammation; it is painful to the touch, exudes a bloody foetid discharge, and may become ulcerated or may be covered with numerous sessile or pedunculate *tumors*, which are very vascular and spongy, and contain the parasites or their eggs. The mucosa of the vagina, also the uterus and bladder, become impregnated with calcareous salts. *Nephritis* develops in grave cases.

If the parasites lodge in the veins of the rectum the lesions caused

are analogous to those described for the genito-urinary tract; among the most prominent symptoms are bloody stools, dysenteric diarrhoea, enterorrhagia, and prolapse of the rectum. The mucosa is studded with numerous papilliform outgrowths, which occasionally attain considerable size and require surgical interference.

The heart, lungs, and liver generally remain normal.

Pathology.—The bladder is reduced in size, while its wall is greatly thickened, due chiefly to the hypertrophy of the muscularis; the mucosa is also thickened, and at certain points it is indurated by uric or calcareous deposits, but the principal lesion consists in ulcerations covered with sanious pus; the mucous membrane is infiltrated with numerous leucocytes, but with few eggs; the submucous connective tissue, however, contains numerous eggs, which also fill the blood vessels; most of the eggs

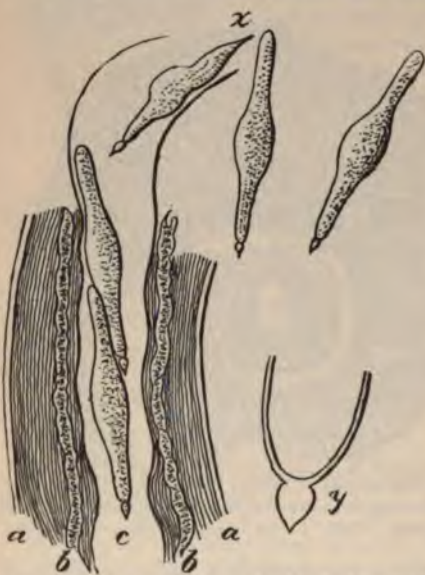


FIG. 47.—Eggs of Bovine Blood Fluke (*Schistosoma bovis*), showing the peculiar process on the end: a, b, layers of the oviduct; c, eggs in the oviduct $\times 180$; x, eggs deformed by pressure; y, spinous process on end of egg $\times 700$. (After Sansino.)

are dead and more or less degenerated; frequently the mucosa is hypertrophied in places so that papillae are formed which are larger than those found in cases of simple catarrh of the bladder; they occasionally attain a finger in length, and may be recognized during life by cystoscopic examination. Harrison noticed in four cases out of five at Alexandria, Egypt, that the tumors developed in the tissue of the bladder had a carcinomatous character. Lesions analogous to those of the bladder are also observed in the lower third of the ureters and may extend as high as the kidney; the ureter is enlarged and tortuous; the mucosa irregular; its lumen may remain nearly normal in size, but its wall becomes very thick. The flow of the urine may be obstructed. The kidney increases in size, its calyx dilates, the division between cortical and medullary substance becomes indistinct, and the renal tissue may be reduced to an almost homogenous layer 3 to 4 mm. thick; miliary abscesses form on the surface; in short, a veritable hydronephrosis obtains, which results in atrophic

lesions of the kidney and may finally end fatally; death may occur rather frequently from albuminuria; in the less grave cases the renal affection consists of a simple inflammation and parenchymatous nephritis; renal calculi may form; the organ may become the seat of a more or less intense cirrhosis. The vesicula seminalis and prostata may also contain eggs, and become more or less hypertrophied.

The polyps of the rectum, mentioned above, may attain 10 mm. to 13 mm. in length; the eggs are accumulated, especially in the mucosa, and may form masses 1.25 mm. thick, visible to the naked eye; a microscopic examination of the growths shows that they are composed in great part of mucosa, the glands (the normal length of which is about 0.5 mm.) becoming 2 to 3 or 3.5 mm. in length by 60μ to 80μ in diameter. Between the polyps the mucosa shows the lesions of chronic dysentery; all the tunics exhibit traces of a slow phlegmatic process; the submucosa is infiltrated with leucocytes; the muscularis may hypertrophy to three or more times its normal thickness.

The mesenteric lymphatic glands may hypertrophy, their substance becoming tumified, presenting small hemorrhagic centers, and containing eggs. The liver may contain eggs and become somewhat cirrhotic; the eggs accumulate in the branches of the portal veins, or after piercing the walls they lie in the hepatic parenchyma. The lungs may also contain eggs, as was shown by Mackie in the case of a patient who succumbed to pyemia following a purulent cystitis. He found in the lungs a large number of small metastatic abscesses limited by a necrotic tissue and containing a sanious pus with *Schistosoma* ova.

Diagnosis.—The diagnosis may easily be made by a microscopic examination of the urine to determine the presence of the egg.

Prognosis, etc.—The severity of the disease varies directly with the number of parasites (and hence the number of eggs) in the body. Fortunately, in the majority of cases the number of parasites is small, though it may increase from repeated infections to 500 or more. In cases of comparatively light infection, the disease is reduced to a slight chronic cystitis, with now and then exacerbations, in course of which a slight amount of blood and pus is passed in the urine. The disease may last for years without apparent increase. In the most severe cases death may occur from various causes; a rupture of the bladder, ascending pyelonephritis, uremia, albuminuria; the patient may die in marasmus, being exhausted by the dysentery or the anaemia.

Bilharziosis is accordingly not such a fatal disease as has sometimes been supposed.

Prevention.—Avoid unfiltered or unboiled water in contaminated districts.

Treatment.—No experiments in treating cattle for this disease have been recorded.

In human practice Fonquet seems to have had good success with capsules of extract of male fern; he begins with one capsule per day, afterward increasing the dose to two or in some cases to three capsules. The dosing is continued with persistency until the patient seems recovered; the dose is then reduced to one capsule daily



FIG. 48.—Ureter of an Egyptian, with numerous uric-acid concretions, as a result of blood-fluke infection. (After Leuckart, 1894, p. 528, fig. 231.)

for one month. Intravesical injections of bichloride of mercury 1:5000 are advised in severe cases. Nitrate of silver, carbolic or boric acid are also used as injections or enemata. Napier claims good results with salicylate of soda; 40 grains before retiring. Surgical intervention is occasionally necessary in cases of severe lesions.



FIG. 49.—Conical amphistomes (*Amphistoma cervi*) in the rumen; tubercles from which the parasites have loosened. (After Railliet, 1893, p. 376, fig. 249.)

ABATTOIR INSPECTION.

At present the blood flukes do not play any rôle in the inspection at American abattoirs. Should the parasite appear in this country it will probably first be found in Southern cattle, and the affected organs should be condemned in order to prevent the spread of the worm. There would, however, be no danger of transmission of the parasite from cattle direct to man.

AMPHISTOMES (Flukes of the Family Amphistomidae).

Of this family of worms, characterized by the position of the acetabulum in the posterior portion of the body, only one species (*Amphistoma cervi*) has as yet been recorded in the herbivorous animals of North America.

TRUE AMPHISTOMES (Flukes of the Genus *Amphistoma*).

9. The Conical Fluke (*Amphistoma cervi*) of Cattle and Sheep.

[Figs. 49-55.]

For anatomical characters, compare figs. 49 and 50 with key, p. 21.

SYNONYMY.—*Festucaria cervi* Zeder, 1789; *Fasciola cervi* (Zeder) Schrank, 1790; *Fasciola elaphi* Gmelin, 1790; *Monostoma elaphi* (Gmelin) Zeder, 1800; *Monostoma conicum* Zeder, 1803; *Amphistoma conicum* (Zeder) Rudolphi, 1809; *Amphistomum conicum* (Zeder) of Diesing, 1850; *Strigea cervi* (Zeder) Railliet, 1893.

BIBLIOGRAPHY.—For bibliography, see Otto (1896, pp. 97, 98). For technical discussion, see Otto (1896), Looss (1896, pp. 32, 33, 185-191), and Leuckart (1894, pp. 448-464).

HOSTS.—Cattle, sheep, deer, and other animals. (See pp. 137-143.)

GEOGRAPHICAL DISTRIBUTION.—Europe, Africa (Egypt), Asia, Australia, Canada, and probably elsewhere.

Life history.—Sonsino found in an Egyptian snail a larval parasite (*Oercaria pigmentata*) which, according to some authors, represents the larval stage of this amphistome. The life cycle has recently been experimentally demonstrated by Looss (1896), who describes it as follows.



FIG. 50.—Dorsal view of a Conical Amphistome, showing the anatomical characters: a, position acetabulum; ex, terminal vesicle of excretory system; i, intestinal caeca; Lc, Laurer's canal; oc, oesophagus; ov, ovary; ph, pharynx; t, testicles; u, uterus; vd, vas deferens; vdt, vitello duct; vs, vesicula seminalis. $\times 5$. (After Otto, 1896, p. 100, fig. 4.)

The eggs escape from the host with the faeces. After a time, evidently varying with the temperature (twelve to fourteen days at 22° C.), a ciliated embryo is formed (fig. 51). This embryo (*miracidium*) escapes from the eggshell only when exposed to light and in case the water is not below 15° C. Swimming around in the water it enters certain snails (*Physa alexandrina* Bourg. and *P. micropleura* Bourg.) establishing itself in the visceral cavity. Here it develops into a *sporocyst* (fig. 52) which, when about fifteen days old, measures 0.7 mm. long by 0.15 mm. broad; a generation

of *rediae* (fig. 53) develops in the sporocyst; the rediae escape from the latter in about fifteen days; a second generation of rediae (fig. 54) forms within the first rediae, escaping by the birth opening; a third generation of rediae may develop within the second. The *cercariae* (fig. 55) form in the rediae and are born at an early stage of development; when fully developed these cercariae escape from the snail and swim around in the water. The entire cycle to this point is evidently completed in less than two months. The cercaria (*Cercaria pigmentata*) is oval, 0.5 mm. long by 0.33 mm. broad with a tail about 0.9 mm. long; body opaque, due

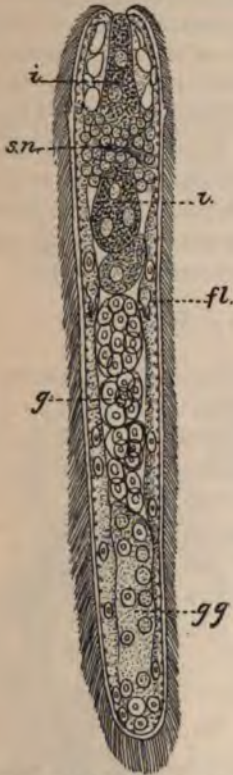


FIG. 51.—Dorsal view of the free embryo (*miracidium*) of the Conical Amphistome (*Amphistoma cervi*) about to enter the intermediate host: *fl*, end portion of excretory system; *g*, germ cells; *gg*, matrix of germ cells; *i*, rudimentary intestine; *sn*, nervous system. $\times 285$. (After Looss, 1896, Pl. XII, fig. 125.)



FIG. 52.—Sporocyst of the Conical Amphistome resulting from the transformation and development of the embryo, age about 15 days: *ex. p.*, excretory pore. *gg*, matrix of germ cells. The large balls of cells represent developing rediae of the next generation. $\times 170$. (After Looss, 1896, Pl. XII, fig. 126.)

to pigment and to certain subtegumentary cells; oral sucker spherical, 45 μ in diameter; acetabulum 90 μ in diameter; two eye-spots present. The cercariae encyst themselves on plants and various other objects and evidently gain access to the final host (cattle, sheep, etc.) through the drinking water.

The Conical Fluke seems to have a very wide distribution, being recorded in Europe, Asia, Africa, North America, and South America. As yet it has not been recorded in the United States, but specimens collected in Canada have been sent to us by Professor Wright, and we may expect to find the same worms any day in the United States.

There is considerable difference of opinion among authors as to whether these parasites are injurious to the animals in which they occur. While some writers state that they are absolutely harmless, others claim that they cause an irritation in the stomach, and that cattle which are heavily infested with them gradually emaciate. According to an Australian paper, the parasites cause a considerable number of deaths among the cattle of the coast districts; they occur in great numbers and injure cows more than steers or oxen. Attaching themselves to the mucous membrane of the stomach, by means of their suckers they raise the epithelium in form of papillae. The treatment is the same as for adult tapeworms (see p. 133).

ABATTOIR INSPECTION.

The amphistomes of cattle are of no importance in meat inspection, as they are not transmissible to man in any stage of their development. In fact, according to Schweinfurth, these parasites are collected by the natives of Africa and eaten raw.

Several other amphistomes are found in various allied ruminants used for food in certain countries, and although these parasites have not yet made their appearance in this country, we can not

FIG. 53.—Adult redia of the Conical Amphistome (*Amphistoma cervi*) of the first generation, thirty-nine days after the infection of the intermediate host with embryos: *fl*, end portion of excretory system; *gg*, matrix of germ cells; *i*, rudimentary intestine; *pg*, birth opening; *sn*, nervous system. (After Looss, 1896, Pl. XII, fig. 129.)

tell what moment we shall find them introduced, perhaps with animals imported for menageries. Should they be introduced in this manner and find the conditions necessary to the development of their larval stages, they would, in all probability, develop in our American cattle. As this day has not yet come, they will simply be mentioned here by name and figured. For anatomical characters, compare the figures with the key on page 21.



FIG. 54.—Young redia of the Conical Amphistome of the second generation in which the cercariae develop. $\times 170$. (After Looss, 1896, Pl. XII, fig. 130.)

10. ¹ *Amphistoma explanatum* Creplin is described from the liver and gall bladder of the zebu; von Linstow (1878, p. 49) cites it as a parasite of cattle; Railliet cites it from the Indian buffalo and the zebu.

11. ² *Amphistoma bothriophorum* Braun (fig. 56) also occurs in the stomach of the zebu.

12. *Amphistoma tuberculatum* was reported by Cobbold (1875, p. 819) from the intestine of the Indian oxen; but no description of the parasite has ever been given, so that the form may be ignored.

13. ³ *Gastrothylax crumenifer* Creplin. This parasite (figs. 57-62) is said to occur in most of the bovine animals (the zebu) killed at Son-Tay; its natural habitat is the stomach, and when present in large numbers they irritate the mucous lining and lead to an extreme emaciation of their host. The same parasite was once found at Leipsic, Germany, in a cross between the zebu, gayal, and yak; and von Linstow (1878, p. 49) cites it among the parasites of cattle.

14. ⁴ *Gastrothylax Cobboldii* Poirier (fig. 63) was described from the stomach of the gayal from Java.

15. ⁴ *Gastrothylax elongatum* Poirier (fig. 64) was described from the stomach of the gayal from Java, and Railliet (1893, p. 379) reports that it has been found in Paris in the stomach of a zebu.

16. ⁵ *Gastrothylax gregarius* Looss (figs. 65 and 66) is found in enormous numbers in the rumen of nearly all the Indian buffaloes slaughtered in Alexandria, Egypt. In one buffalo Looss counted 1,758 specimens on a portion of the mucosa as large as a hand. They were often found associated with *Amphistoma cervi*.

17. ⁴ *Homalogaster palonias* Poirier (fig. 67) is found in the caecum of the gayal in Java.

18. ⁶ *Homalogaster Poirieri* Giard & Billet is found in the large intestine of Tonkin



FIG. 56.—*Amphistoma bothriophorum*: a, position of acetabulum; ex, terminal vesicle of excretory system; i, intestinal caeca; Lc, Laurer's canal; oc, oesophagus; ov, ovary; ph, pharynx; t, testicles; u, uterus; vd, vas deferens. $\times 5$. (After Otto, 1896, p. 102, fig. 5.)



FIG. 55.—Mature cercaria of the Conical Amphistome (*Amphistoma cervi*), the stage which gains access to cattle and sheep. $\times 75$. (After Looss, 1896, Pl. XII, fig. 133.) See p. 65.

cattle (= ? the zebu). It fixes itself by means of the acetabulum to the mucosa and is sometimes present in large numbers.

¹ For original description, see Creplin, 1847, pp. 34 and 35.

² For technical discussion, see Otto, 1896, pp. 101-105.

³ *Amphistoma crumeniferum* Creplin, 1847; *Gastrothylax crumeniferum* (Creplin) Poirier, 1883; *G. crumenifer* (Creplin) Otto, 1896. For bibliography and technical discussion, see Otto, 1896, pp. 94-97.

⁴ For technical discussion, see Poirier, 1883, pp. 73-80.

⁵ For technical discussion, see Looss, 1896, pp. 5-13, 170-177.

⁶ For original description, see Giard & Billet, 1892, pp. 614 and 615.

TAPEWORMS, OR CESTODES (Order Cestoda).

[Segmented Tapeworms (suborder *Tomiosoma*). Tapeworms without four retractile probosces (tribe *Atrypanorhyncha*). Tapeworms with four suckers (subtribe *Tetrassichionia*).]

Family TAENIIDAE.

In cattle and sheep we find both of the stages of tapeworms mentioned on page 21, namely:

Larval forms (cystic worms, bladder worms, hydatids) which live in the muscles or parenchymatous organs, but not in the intestine. They render the meat unfit for food since they are transmissible (according to the species) to man and dogs; and—

Adult worms (tapeworms, strobilae) which occur in the intestines of sheep and cattle (rarely in the ducts of the liver of sheep) and are not transmissible to carnivorous animals.

FIG. 57.—Enlarged dorsal view of *Gastrothylax crumenifer*. (After Creplin, 1847, Pl. II, fig. 1.) See p. 67.



Hogs on the other hand appear to be infested only with larval tapeworms, although three isolated cases of adult tapeworms have been recorded for them. These three cases may have been accidental occurrences, the hogs having possibly become accidentally infested with worms which normally live in other animals.

FIG. 59.—Enlarged view of anterior extremity of *Gastrothylax crumenifer*: m, mouth; ep, opening to ventral pouch. (After Creplin, 1847, Pl. II, fig. 4.) See p. 67.



Tapeworms of the family Taeniidae possess the following characters: The anterior extremity is represented by a more or less knob-like portion known as the *head*; this is followed by an unsegmented portion, the *neck*; head and neck together form the *scolex*; this in turn by the *segments*, or *proglottids*. The head is provided with four cup-shaped suckers, which are never provided with hooks in any form known in cattle, sheep, or hogs, but are armed with numerous hooklets in some of the forms found in certain other animals (man, rabbits, birds). The apex of the head is provided with a muscular body, which develops into different forms in the various subfamilies. It may form a *rostellum*, which may be unarmed (*Taenia saginata*) or armed (*Taenia solium*). In the larval forms discussed in this paper (*Taeniinae*) the rostellum protrudes at the center of the apex, but in some other forms (*Dipylidiinae*) it may retract into a rostellum sac. In the adult tapeworms (*Anoplocephalinae*) of cattle, sheep, etc., the muscular body is composed of stellate fibers which move the suckers, but these fibers do not appear to form a true rostellum.

The *neck* is very simple in structure, containing each side two longitudinal canals and a longitudinal nerve trunk. At the posterior portion of the neck, segments form by transverse division.

The *segments* increase in size, gradually becoming larger the farther they are from the head; reaching a maximum breadth, they decrease in width, and then increase in length more rapidly. The anterior segments are the youngest, the posterior seg-

FIG. 58.—Enlarged ventral view of *Gastrothylax crumenifer*: a, acetabulum; ep, opening to the ventral pouch. (After Creplin, 1847, Pl. II, fig. 2.) See p. 67.



FIG. 60.—Enlarged view of posterior extremity of *Gastrothylax crumenifer*. See p. 67.



ments the oldest. Many zoologists look upon the entire tapeworm as a colony of animals, each separate segment representing a single individual, and all segments being descended from a single animal represented by the head and neck.

Owing to their parasitic life, tapeworms are very degraded in their structure. The *digestive tract* is entirely absent, the worms taking their nourishment by osmosis through their entire surface. The *nervous system* is composed of nerve centers (ganglia), situated in the head, and two large lateral nerves, one of which extends on each side of the worm from the head to the posterior end of the strobila; in some cases, at

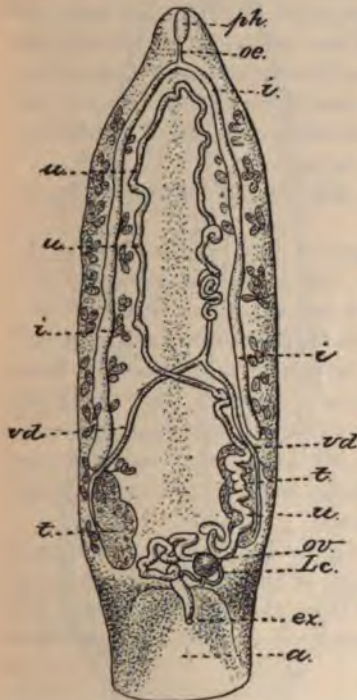


FIG. 62.—Dorsal view of *Gastrothylax crumenifer*, magnified to show the anatomical characters: *a*, acetabulum; *ex*, terminal vesicle of excretory system; *i*, intestinal caeca; *Lc*, Laurer's canal; *oe*, oesophagus; *ov*, ovary; *ph*, pharynx; *t*, testis; *u*, uterus; *vd*, vas deferens. $\times 5$. (After Otto, 1896, p. 96, fig. 3.) See p. 67.

(except in the genus *Amabilia*, according to Diamare) opening at the same pore. In some species, so-called *interproglottidal glands* of unknown function are found between the segments.

Life history.—Tapeworms pass through three stages of development, known as the *oncosphere* (or embryo), the larva (a bladder worm known as a *cysticercus*, a *coenurus*, an *echinococcus*, or a *cysticercoid*), and an adult form known as the *strobila*. A change of host is necessary for their development; the host in which the oncosphere develops into the larva is known as the *intermediate host*,



FIG. 61.—Enlarged view of *Gastrothylax crumenifer*, with ventral pouch open: *a*, acetabulum; *gp*, genital pore; *m*, mouth. (After Creplin, 1847, Pl. II, fig. 5.) See p. 67.

least, the lateral nerves are connected by two transverse nerves at the distal end of each segment. The *excretory system* consists of two dorsal and two ventral longitudinal lateral canals, which are connected in various ways in the head; the *ventral canals* are connected by *transverse canals* at the posterior border of each segment. The *genital organs* form by far the most important organ system in the animal. In the first place, the entire genital system is repeated, so that each segment as it arrives at a given age possesses its own genital organs, independent of the organs of the other segments. Again, every segment is hermaphroditic, containing both male and female organs, and in some genera the segments are doubly hermaphroditic, containing double sets of male and of female organs. The *male organs* consist of a cirrus (penis), a cirrus pouch, a vas deferens, and numerous testicles. The *female organs* consist of a vulva, a vagina, an ovary, a vitellogene gland, a shell gland, oviducts, and a uterus. Each segment possesses one or two genital pores, the cirrus and the vulva of any given set of organs



FIG. 63.—*Gastrothylax Cobboldii*, lateral view: *a*, acetabulum; *i*, intestine; *m*, mouth; *vp*, opening to ventral pouch. (After Poirier, 1883, Pl. II, fig. 3b. Taken from Braun, Vermes, Pl. XVIII, fig. 2.) See p. 67.

while the animal which harbors the adult form is known as the *final host*. The life history of *Taenia saginata* given on page 72 may be taken as typical for the family.

All of the larval cestodes of cattle, sheep, and swine belong to the subfamily *Taeniinae*, while all the adult forms found in these hosts are classified in the subfamily *Anoplocephalinae*.

Hard-shell Tapeworms (Cestodes of the Subfamily *Taeniinae*).

The Hard-shell Tapeworms, so called because of the thick striated eggshell (embryophore), are found as adults in the intestines of meat-eating mammals, while their larval stage is found in the muscles or

parenchymatous organs of herbivorous and omnivorous animals. These larval forms are very important from the standpoint of meat inspection, and organs which harbor them should be excluded from the market or should be rendered wholesome before being placed on sale.

The larval forms may be of three kinds, as follows:

(1) *Cysticercus* (figs. 68 and 76).—This is the most simple form. The parasite consists of a cyst, which is invaginated at a given point. There is normally only one invagination to each cyst, and at the base of the invagination is situated the head of the future tapeworm. Besides the invagination, the cyst contains more or less liquid.

(2) *Coenurus* (figs. 99 and 100).—In this case there is a considerable number of invaginations, each containing a head.

(3) *Echinococcus* (fig. 105).—In the third type there is no invagination of the cyst wall, but brood capsules are formed from the parenchyma of the cyst and several heads are formed in each brood capsule.

Attempts have been made to subdivide the *Taeniinae* into genera and subgenera, the genus *Taenia* Linnaeus being retained for the forms which possess a *Cysticercus* or a *Coenurus* as larval form, while *Echinococcifer* Weinland, 1861, has been proposed as the generic name for *Taenia echinococcus*. This generic division has not been accepted by the majority of helminthologists, most workers preferring to recognize only one genus, *Taenia*, but many authors admitting three subgenera, corresponding to the three types of larvae.

HARD-SHELL TAPEWORMS (Genus *Taenia*).

The following species of this genus must be considered in this report:

Adult.		Larva.	
Name.	Host.	Name.	Host.
<i>Taenia saginata</i>	Man....	<i>Cysticercus bovis</i>	Cattle.
<i>Taenia solium</i>	Man....	<i>Cysticercus cellulosae</i>	Swine and man.
<i>Taenia marginata</i>	Dogs....	<i>Cysticercus tenuicollis</i>	Cattle, sheep, and swine.
<i>Taenia coenurus</i>	Dogs....	<i>Coenurus cerebralis</i>	Cattle and sheep.
<i>Taenia echinococcus</i>	Dogs....	<i>Echinococcus polymorphus</i>	Cattle, sheep, swine, man, etc.

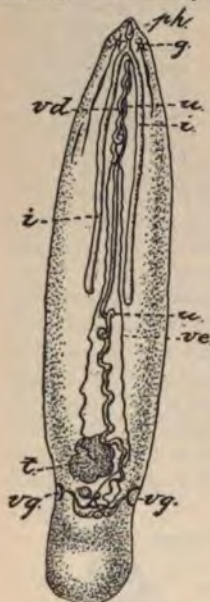


FIG. 64.—*Gastrothylax elongatum*: g, ganglion; i, intestinal caeca; ph, pharyngeal bulb; t, testicle; u, uterus; vd, vas deferens (ductus ejaculatorius); ve, vasa efferentia; vg, vitellogene glands. (After Poirier, 1883, Pl. II, fig. 2b. Taken from Braun, Vermes, Pl. XVIII, fig. 7.) See p. 67.

19. Beef Measles (*Cysticercus bovis*) of Cattle, and its adult stage, The Unarmed, or Beef Measle, Tapeworm (*Taenia saginata*) of Man.

[Figs. 68-74.]

LARVAL STAGE (*Cysticercus bovis*).

For anatomical characters, compare fig. 68 with key, p. 21.

SYNONYMY.—*Cysticercus Taeniae saginatae* Leuckart, 18—(?); *C. bovis* Cobbold,

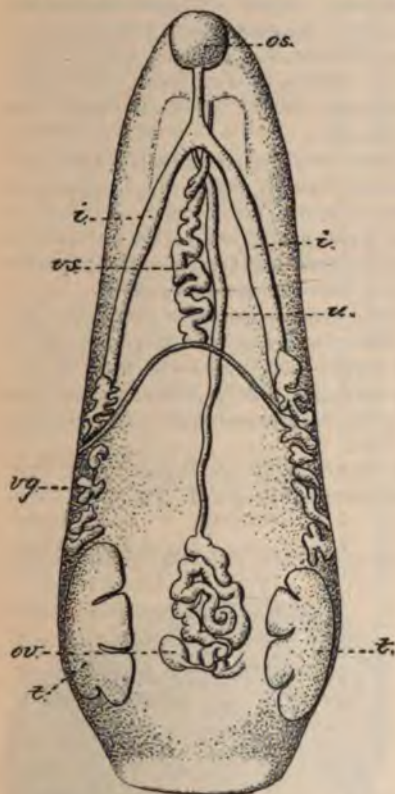


FIG. 65.—Dorsal view of *Gastrothylax gregarius*: *i.*, intestinal caeca; *os.*, oral sucker; *ov.*, ovary; *t.*, testicles; *u.*, uterus; *vg.*, vitellogene glands; *va.*, vesicula seminalis. $\times 9$. (After Looss, 1896, fig. 1.) See p. 67.

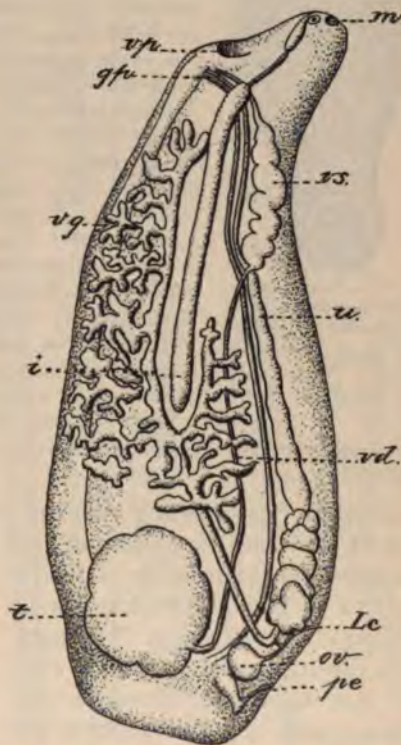


FIG. 66.—Lateral view of *Gastrothylax gregarius*: *gp.*, genital pore; *i.*, intestinal caeca; *m.*, mouth; *Le.*, opening of Laurer's canal; *ov.*, ovary; *pe.*, excretory pore; *t.*, testicle; *u.*, uterus; *vd.*, vas deferens; *vg.*, vitellogene gland; *vs.*, vesicula seminalis. $\times 9$. (After Looss, 1896, fig. 2.) See p. 67.

1866; *C. Taeniae mediocancellatae* Knoch, 1868; *C. inermis* of various Germans and others, 18—(?); "*Cysticercus*" *bovis* of Schneidemühl, 1896.

HOSTS.—Cattle, Rocky Mountain "antelope," llama, and giraffe. (See pp. 137-143.)

ADULT STAGE (*Taenia saginata* (Goeze, 1782)).

For anatomical characters, compare figs. 69-73 with key, p. 84.

SYNONYMY (see also pp. 89-90).—*Taenia solium* Linnaeus, 1758, pro parte; *T. cucurbitina* Pallas, 1781, pro parte; *T. cucurbitina* Art [= var.] *saginata* Goeze, 1782; *T. cucurbitina, grandis, saginata* Goeze, 1782; *T. solitaria* Leske, (1785), pro parte; *Halyalis*

solium (Linnaeus) Zeder, 1803, pro parte; *Pentastoma coarctata* Virey, 1823; "*T. dentata*" Nicolai, (1830) [nec Batsch, 1786]; "*T. lata*" Pruner, 1847 [nec Linnaeus, 1758]; *Bothriocephalus tropicus* Schmidt Müller, 1847; *T. mediocancellata hominis*, seu *T. mediocancellata* seu *T. zittaviensis* Küchenmeister, 1852; *T. solium* var. *mediocancellata* (Küchenmeister) Diesing, 1854; *Taenia-rhynchus mediocancellata* (Küchenmeister) Weinland, 1858; (?) *Taenia solium* var. *abietina* Weinland, 1858; *T. inermis* Moquin-Tandon, 1860; *T. mediocancellata* (-?-), date (?), see Moquin-Tandon, 1860; *T. tropica* (Schmidt Müller) Moquin-Tandon, 1860; *T. megaloon* Weinland, (1861); *T. (Cystotaenia) mediocancellata* of Leuckart, 1863; *T. saginata* (Goeze, 1782) of Leuckart, 1867; (?) *T. abietina* Weinland of Davaine, 1873; *T. inermis* Laboulbène, 1876; *T. algérien*, Redon, 1883; (?) *T. solium* var. *minor* Guzzardi Asmundo, 1885; *T. algeriensis* Braun, 1894 (= *T. algérien* Redon renamed).

ANOMALIES.—(?) "*Taenia vulgaris*" Werner, 1782 [nec Linnaeus, 1758] = *T. dentata* Batsch, 1786; (?) *T. fenestrata* Chiaje, 1833; *T. capensis* Moquin-Tandon, 1860; *T. lophosoma* Cobbold, 1866; *T. fusa*, *T. continua*, *T. solium fusa* seu *continua* Colin, 1876; *T. mummificata* Guzzardi Asmundo, 1885; *T. nigra* Davaine, 1877; *T. inermis fenestrata* Maggiora, 1891.

PRE-LINNAEAN NAMES.—*Vermis cucurbitinus* composing *Taenia longissima* Plater, 1609; *Lumbricus latus* Movfetius, (1634); *Taenia secunda* Plateri Ernst, 1659; *Lumbricus latus* Tyson, 1683; *Solium* ou *Ténia sans épine* Andry, (1700); *Taenia de la seconde espèce* Andry, 1718; *Taenia sans épine* ou *Taenia de la première espèce* Andry, 1741.

FIG. 67.—*Homalogaster paloninae*, ventral view. (After Poirier, 1883, Pl. II, fig. 1a. Taken from Braun, Vermes, Pl. XVIII, fig. 3.) See p. 67.

BIBLIOGRAPHY.—For bibliography, see Huber (1892). For technical discussion, see Leuckart (1880, pp. 513-616); R. Blanchard (1886, pp. 315-382).

HOST.—Man.

Life history.—Starting with the adult tapeworm (fig. 69) in the intestine of man, the life history of the parasite, the knowledge of which we owe to Rudolf Leuckart, is as follows: The eggs (fig. 74) escape from the uterus and are passed with the excreta, or the segments containing eggs break loose from the tapeworm and either wander out of the intestine of their own accord or are passed with the excreta. In either case the eggs become scattered upon the ground or in water, and reach the cattle through their drinking water or with the fodder. When whole segments (generally several together) are passed, these crawl around on the ground or herbage, and cattle by swallowing them may become infected with numerous eggs at the same time. Upon arriving in the stomach, the eggshells are destroyed; the embryo then bores its

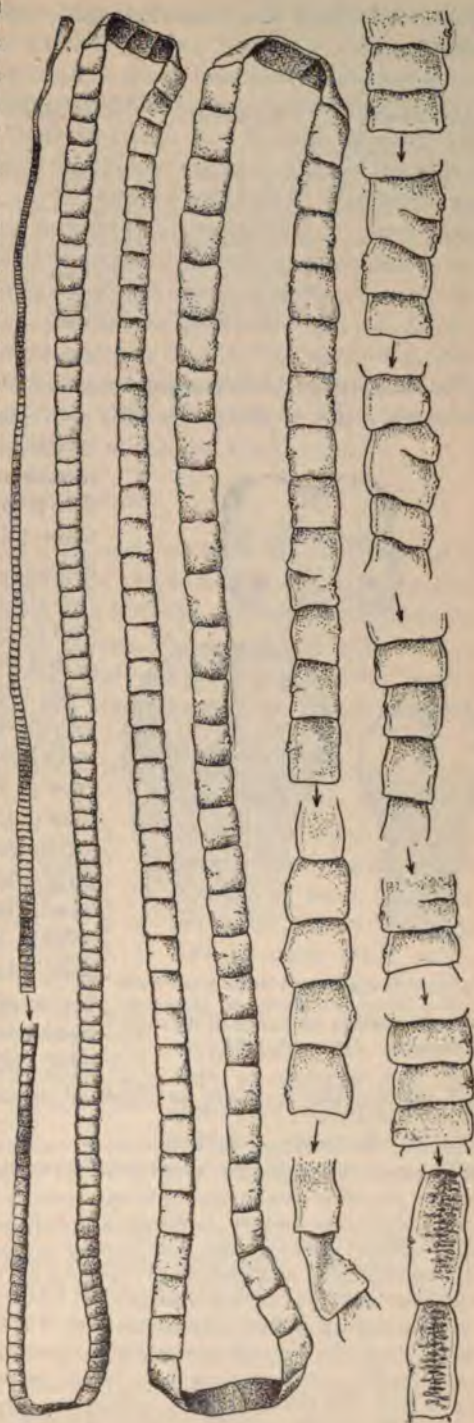


FIG. 68.—Section of a beef tongue heavily infested with beef measles, natural size (original).

way through the intestinal walls with the aid of its six minute hooks, and wanders to the muscles where it comes to rest; or if it bores into a blood vessel, it may be carried with the blood to any organ of the body. When the embryo comes to rest it loses its hooks, and, increasing in size, develops into a small round bladder worm. The head of the future tapeworm is then developed in an invagination of the cyst wall, and the complete organism (fig. 68) thus formed is known as a *cysticercus*, or bladder worm. During its development the cyst pushes the tissues of the host aside to make room for itself and an outer cyst is formed around it, made up of connective tissue of the host. The total time consumed in the development of the *cysticercus* from the embryo is variously estimated from seven to eighteen weeks.

Hertwig states that the larva has completed its development in eighteen

FIG. 69.—Several portions of an adult Beef-meat Tapeworm (*Taenia saginata*) from man, showing the head on the anterior end and the gradual increase in size of the segments, natural size (original).



weeks, and gives the following table to determine the age¹ of the cysticercus:

Age in weeks.	Entire cyst.	Cysticercus without connective tissue cyst.	Scolex.	
			Natural size.	Stretched.
4.....	4.0 by 3.5 mm.....	2.25 by 2.25 mm.....	0.5 by 0.5 mm.....	0.7 mm. long.
6.....	4.2 by 3.5 mm.....	3 by 2.5 mm.....	1 by 1 mm.....	1.3 mm. long.
8.....	4.5 by 3.5 mm.....	3.25 by 2.75 mm.....	1.5 by 1 mm.....	2.9 mm. long.
10.....	5 by 3.75-4 mm.....	3.5 by 3.5 mm.....	1.75 by 1 mm.....	3.3 mm. long.
12.....	5.6 by 3.5-4 mm.....	4 by 4 mm.....	1.8 by 1 mm.....	3.5 mm. long.
14.....	6 by 4.5 mm.....	5 by 4.5 mm.....	2 by 1 mm.....	4 mm. long.
16.....	6 by 4.5 mm.....	5 by 4.5 mm.....	2 by 1 mm.....	4.25 mm. long.
18.....	6.25-7 by 4.5 mm.....	6 by 4 mm.....	2 by 1.25 mm.....	5 mm. long.
22.....	6.5-8 by 4.5 mm.....	6 by 4.5 mm.....	2.25 by 1.75 mm.....	5.5-6.25 mm. long.
28.....	7.5-9 by 5.5 mm.....	7 by 5 mm.....	2.5 by 2 mm.....	7 mm. long.

The calcareous bodies may appear when the bladder worm is four weeks old; the suckers are fully developed at the eighteenth week.

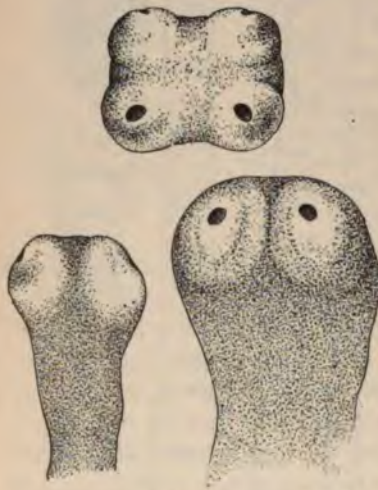


FIG. 70.—Dorsal, apex, and lateral views of the head of Beef-measle Tapeworm (*Taenia saginata*), showing a depression in the center of the apex. $\times 17$. (Original.)

Occasionally bladder worms are found measuring 10 to 12 mm., with a scolex 8 to 9 mm.; these parasites are more than 28 weeks old. If the infested animal is not slaughtered and does not die the cysts will eventually die and degenerate. Thus, in one animal killed 224 days after being infected with tapeworm eggs, the cysts were calcified (Saint-Cyr). The parasites which inhabit the seats of predilection (see p. 78) seem to be the last to die. The degeneration may include (1) the surrounding connective tissue capsule, which becomes opaque and thickened, (2) the bladder cyst of the worm, which turns to a yellowish green, soft, cheesy mass, or (3) both. If, however, the animal is slaughtered before the cysticerci become calcified, and the meat used for food, the

cyst around the hydatid is digested upon arriving in the stomach of

¹ During the proof reading of this report an article by Ostertag (1897, pp. 1-4) has reached us, in which he adds some details of value in judging the age of the bladder worms. His chief results may be summarized as follows:

(1) A steer may become infected with beef measles, and yet recover from the attack without showing upon post-mortem any calcified cysts. (2) *C. bovis*, 18 days old, is spindleform, and measures 4 mm. long by 2 mm. broad; a differentiation into scolex and bladder is not yet present. (3) Up to 33 days after infection the parasite is surrounded by a cheesy mass, the result of exudation; this afterward disappears. (4) At 25 days old the parasite shows the primordium of the scolex, with faint indication of the suckers. (5) When the parasite is 59 days old the suckers may be seen with the naked eye; calcareous corpuscles are also present. (6) The lumen of the suckers is visible in parasites 73 days old.

man. The hydatid cyst is also digested, the head and neck alone remaining uninjured. The scolex then passes from the stomach into the small intestine, fastens itself to the wall by means of its suckers, and gives rise to segments by transverse division (strobilization) directly back of the head and neck. New segments are formed between the head and the old segments, so that the last segment is always the oldest and the segment nearest the head always the youngest. Segments are formed so rapidly that the worm is full grown at the end of about three months. Perroncito estimates that about 13 to 14 new segments are formed each day, length of the the first month Genital organs, segment, em completed to the

which results in an average increase in the worm at the rate of about 3 cm. per day for and 14 cm. per day for the second month. both male and female, are developed in every bryos are produced, and the life cycle is point from which we started out.

BEEF MEASLES.

cattle.—*Cysticercus bovis* has been found in etal muscles, in the heart, the adipose tissue around the kidneys, the subperitoneal connective tissue, the lymphatic glands, and between the convolutions of the brain; cases are also reported of its presence in the lungs and liver.

In some infections of cattle which have been made no symptoms of disease were noticed, but in others quite severe symptoms have been observed. About fifteen to twenty days after infection the animals became feverish, the sickness increasing to the twenty-fifth to sixtieth day, the patients becoming emaciated. Several cases

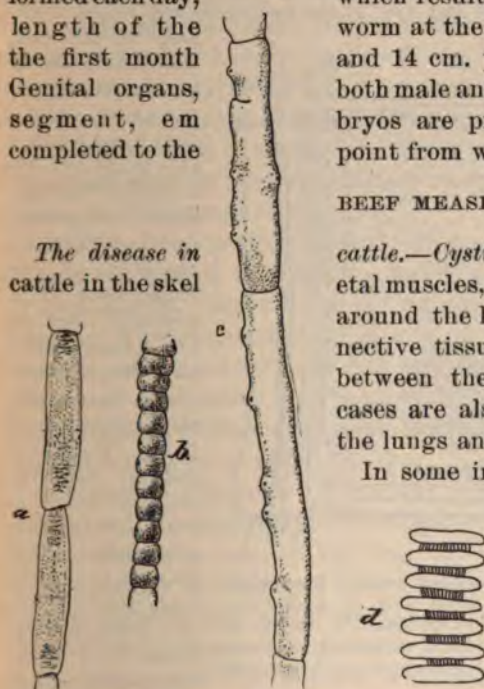


FIG. 71.—Segments from various strobilae of Beef-measle Tapeworm (*Taenia saginata*) showing forms of proglottids which are occasionally found: a, elongated segments; b, beadlike segments; c, a portion of strobila in which the segmentation is not distinct; d, moniliform segments (a and b original; c and d after R. Blanchard, 1894).

proved fatal, while others recovered and were apparently none the worse for the experiment.

These symptoms have been noticed only in cattle which have been experimented upon and which have received enormous infections, and it is very generally supposed that an ordinary infection will have little or no effect upon the animals; we can, however, easily imagine that such an infection as Fleming describes, where he found 300 cysticerci in one pound of muscle, will injure the host. When the heart is heavily infected its action must be seriously impeded. As an example

of an extreme case we may take the following description of symptoms and post-mortem examination, taken from Züri (1882, p. 187):

Symptoms.—Four days after feeding segments of *T. saginata* to a healthy three-months-old calf, the patient showed a higher temperature (the normal temperature was 39.2 C.) The calf ate but little on that day, showed an accelerated pulse, swollen belly, staring coat, and upon pressure on the sides showed signs of pain. The next day the animal was more lively, ate a little, and for nine days later did not show any special symptoms except pain on pressure of the abdominal walls, and a slight fever. Nine days after the infection the temperature was 40.7 C., pulse 86, respiration 22; the calf laid down most of the time, lost its appetite almost entirely, and groaned considerably. When driven it showed a stiff gait and evident pain in the side. The fever increased gradually and with it the feebleness and low spirited-

ness of the calf, which now retained a recumbent position most of the time, being scarcely able to rise without aid, and eating only mash with ground corn. Diarrhea commenced, the temperature fell gradually, and on the twenty-third day the animal died. The temperature had fallen to 38.2 C. During the last few days the calf was unable to rise; in fact, it could scarcely raise its head to lick the mash placed before it. Pulse was reduced by 10 beats. On the last day the heart beats were

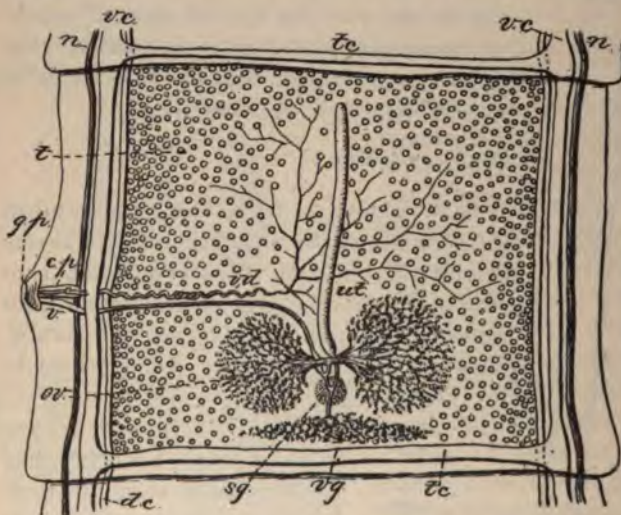


FIG. 72.—Sexually mature segment of Beef-meat Tapeworm (*Taenia saginata*): *cp*, cirrus pouch, with cirrus; *dc*, dorsal canal; *gp*, genital pore; *n*, lateral longitudinal nerves; *ov*, ovary; *sg*, shell gland; *t*, testicles; *ut*, median uterine stem; *v*, vagina; *ec*, ventral canal, connected by transverse canal; *td*, vas deferens; *vg*, vitellogene gland, enlarged (in part after Leuckart).

very much slower, yet firm, and could be plainly felt. Several days before death the breathing was labored and on the last day there was extreme dyspnoea. * * *

Post-mortem.—Body cavities contained reddish serous exudate. Subdermal connective tissue was oedematous. Muscles were redder than usual, in some places very dark red. In the heart muscles were innumerable (many thousand) round tubercle-like bodies, 1.5 to 3 mm. long, 1.2 to 5 mm. wide, yellowish-white in color. Young cysticerci lay embedded in these smeary chalky cysts. Some of these cysticerci were round, but the majority were bottle-shaped and contained round cells and fat globules, and were inclosed by a membrane.

The bottle-shaped cysticerci measured 0.557 mm. long while their greatest diameter was 0.326 mm. Cysts were also found in all the muscles, especially in the muscles of mastication, dorsal muscles of the neck, etc., and finally, though not many, in the diaphragm, and outer and inner diagonal abdominal muscles.

Acute cestode tuberculosis is a name which is sometimes applied to designate a heavy infection with cysticerci.

Failing to diagnose the presence of the parasites by symptoms exhibited by the cattle, we have recourse to other methods which have occasionally proved of use:

(1) By examining the under side of the tongue it is occasionally possible to find small lumps about the size of a pea or bean which can be moved slightly with the fingers, and which in many cases represent cysticerci. It is rare that this method leads to any practical results, and no confidence should be placed in it.

(2) Several authors suggest cutting out a portion of muscle—one of the neck muscles, for instance—and examining it for the cysts. Although the diagnosis may sometimes be made by operating in this manner, we can hardly see how it can be of any practical value, since no treatment, except good nourishment, which cattle should always have, can at present be suggested for animals infested with these parasites. Moreover, extirpation of a muscle should be practiced only by professionals, and a negative diagnosis in this case is of no value.

(3) The only positive diagnosis is post-mortem examination, and this, for the comfort of man, as will be shown, should be made on all slaughtered cattle. An examination of the internal and external muscles of the jaws, the tongue and neck, as well as the heart and muscles seen from the body cavity, will generally suffice to determine whether the cysticerci are present or not.

Treatment.—There is no medical treatment to be suggested. *Prevention*, however, is extremely simple. We have seen (p. 72) that cattle obtain the eggs directly or indirectly from human excrements; hence persons who have this tapeworm should not void their excrements in fields or barns where they can contaminate the fodder or water used for cattle. If this plan is followed, not only will the spread of the parasite among cattle be prevented, but also the spread of this species of tapeworm among man, since the latter, as has already been stated, becomes infected by eating meat containing the larval stage. It lies entirely within the power of the inhabitants in stock-raising districts to prevent the infection of their cattle with this parasite.



FIG. 73.—Gravid segment of Beef-measle Tapeworm (*Taenia saginata*), showing lateral branches of the uterus, enlarged (original).

ABATTOIR INSPECTION.¹

As beef measles, when swallowed by man, gives rise to an adult tapeworm, the question of using meat infested with this parasite and

¹ Since this report was sent to press we have received a very extensive article upon abattoir inspection for beef measles, written by Rasmussen (1897), of Copenhagen. Persons who wish to inform themselves upon this subject more in detail are referred to the articles by Rasmussen (1897) and Friis (1897).

the question of abattoir inspection naturally arise. Although this species of tapeworm does not contribute to the comfort of man, it can not be looked upon as a dangerous parasite. It may bring about digestive troubles, but will not per se result in the death of the patient; and with proper treatment it can be gotten rid of, although sometimes with difficulty. Nevertheless, its presence in man should, of course, be prevented when possible, and this can be done by very simple means, namely, (1) by an inspection of cattle at the slaughterhouses to determine the presence or absence of the larval stage, and (2) by submitting infested meat to processes which kill the parasites.

(1) *Position of the parasites.*—Inspectors should examine very thoroughly the muscles of all cattle slaughtered, especially the inner and outer muscles of mastication and the heart; cuts should be made into the muscles of the jaws parallel to the bones.

The following table, taken from Ostertag, giving the result of the meat inspection in Berlin for 1889-90, is exceedingly instructive, as it shows the general distribution of the parasites in the various muscles:

	Cases.
(1) In muscles of the jaws.....	316
(2) In muscles of the jaws and in the heart	39
(3) In muscles of the jaws and in the tongue.....	4
(4) In muscles of the jaws and in the neck.....	1
(5) In muscles of the neck.....	1
(6) In muscles of the neck and in the tongue.....	1
(7) In muscles of the tongue.....	2
(8) In muscles of the tongue and heart.....	2
(9) In muscles of the tongue and muscles of breast.....	1
(10) General infection.....	22

Thus it is seen that in these examinations the muscles of the jaws were infested 360 times, while the other organs were infested but 55 times (in this computation the 22 cases of general infection are omitted); in other words, in about seven-eighths of all cases found parasites were present in the muscles of the jaws. Occasionally, in very heavy infections, the parasites occur also in the lymphatic glands, the lungs, the liver, the brain, etc.

The recognition of the fully developed bladder worms is an easy matter for anyone who understands the structure of the parasite; although their detection in superficial layers is rendered somewhat difficult in case the surface of the meat becomes dried. In case of doubt the suspected cysticercus may be placed between two fingers and a gradual pressure exerted upon the cyst. This will cause the protrusion of the head, upon which the four suckers can be easily distinguished. A simple microscopic preparation of the parasite, made by pressing it between two pieces of glass, will reveal the presence of the calcareous corpuscles of the parenchyma.

Differential diagnosis.—The only parasites in cattle which would be likely to be mistaken for beef measles are *Cysticercus tenuicollis* (see

p. 96) and *Echinococcus polymorphus*. The absence of hooks, however, immediately distinguishes the Beef-measle Bladder Worm (*Cysticercus bovis*) from *C. tenuicollis*, which occurs in the serous membranes, etc., but not in the muscles. Young stages of the echinococcus hydatid, which are occasionally found in the muscles, differ from the Beef-measle Bladder Worm in several characters, which render a differential diagnosis comparatively easy, as seen from the following table:

<i>Cysticercus bovis</i> .	<i>Echinococcus</i> , p. 113.
One unarmed head present..	Head absent or numerous armed heads present in brood capsules (p. 116).
Cuticle thin.....	Cuticle thick and laminated (p. 116).
Form oval.....	Form round.

A positive diagnosis of the younger stages of *C. bovis* (i. e., before the head has developed), or of degenerated specimens, is sometimes more difficult; the younger stages and the totally degenerated specimens will not develop further if eaten; the specimens which are only partially degenerated may, however, still retain enough vitality to develop into adult tapeworms. The oval or pyriform body gives a probable diagnosis for the younger stages, while the presence of calcareous corpuscles (seen only with the microscope) furnishes a method of diagnosis for the degenerated forms. Even in completely degenerated cysts the calcareous bodies may be discovered; these should, however, not be mistaken for fat globules which are more strongly refractive, possess a broader and darker edge, and do not change on addition of acetic acid. It is more difficult to distinguish the calcareous corpuscles from certain crystals of calcium carbonate; the latter lie in clumps and overlap each other, and upon being treated with mineral acids (as weak hydrochloric acid) completely disappear, while when the calcareous corpuscles are treated with acids their organic base retains the original form.

Rissling gives the following method for determining the presence of cysticerci in chopped meat and sausage, but its application does not seem very practicable, for this country at least. It appears to us much better to inspect meat for measles before it is cut up.

Prepare 1 to 4 liters of a solution of caustic soda or caustic potash having a specific gravity of 1.15; place this, together with the teased or chopped meat, in a funnel-shaped dish, stir well and allow to stand. The worms will then sink to the bottom while the rest of the material will float.

Schmidt-Mülheim's method consists in artificially digesting the meat at 40° C. After several hours the bladder portion of the cysticerci will be more or less destroyed, but the heads will not be affected; they sink to the bottom of the vessel and may be recognized as small white bodies. In armed cysticerci (*C. cellulosae*, p. 89, etc.) the hooks will be found.

Frequency of Cysticercus bovis in cattle.—No exact statistics have been published for this country. The proportions of infected cattle slaughtered in Prussia for 1892 were as follows:

Regierungsbezirk.	Proportion.	Regierungsbezirk.	Proportion.
Stralsund.....	1:51	Kassel.....	1:1,653
Oppeln.....	1:229	Bromberg.....	
Hannover.....	1:350	Breslau.....	1:2,500
Lüneburg.....	1:426	Arnsberg.....	
Danzig.....	1:610	Koblenz.....	1:3,500
Berlin.....	1:775	Stettin.....	
Marienwerder.....	1:775	Posen.....	1:6,659
Frankfurt.....	1:915	Königsberg.....	1:20,000
Merseburg.....	1:1,025	Liegnitz.....	1:25,586
Schleswig.....		Düsseldorf.....	1:34,182
Potsdam.....		Wiesbaden.....	
Hildesheim.....			

The average proportion for the first 20 Regierungsbezirke mentioned was 1:1,631. These statistics appear rather low when we notice the following figures for the Berlin abattoir:

Year.	Cattle slaughtered.	Cattle infected.	Proportion.
1883-88.....		2	
1888-89.....	141,814	113	1:1,255
1889-90.....	154,218	390	1:395
1890-91.....	124,593	263	1:474
1891-92.....	136,368	254	1:541
1892-93.....	142,874	214	1:672

This apparent increase in proportion from 1:1,255 in 1888-89 to 1:672 in 1892-93 is due to the more thorough inspection following Hertwig's discovery of the seats of predilection of the parasite, rather than an actual increase in the number of animals infected.

Influence of age and sex of the host.—According to certain European statistics about 50 per cent of the cases of infection are found in animals 2 years old; about 20 per cent of the cases in animals 3 years old, and about 4.5 per cent in animals of 1, 4, 5, 6, 7, and 8 years old, respectively. Beef measles are also said to be more common in male animals than in female animals.

Influence of season.—According to Rasmussen, bladder worms are more common in late summer and early fall than at other times of the year. From statistics he gives for Copenhagen it appears that for the years 1890-96, the total number of cases found and their proportion to the entire number of animals slaughtered were as follows:

Months.	Cases.	Per cent.	Months.	Cases.	Per cent.
January.....	39	0.17	July.....	13	0.10
February.....	38	.19	August.....	52	.31
March.....	43	.20	September.....	69	.32
April.....	20	.10	October.....	81	.35
May.....	24	.12	November.....	54	.24
June.....	13	.09	December.....	38	.18

Disposition of measly beef.—Measly beef should be condemned to the tank as unfit for food when the infection is general, or when the invasion by the parasites has caused a watery and "flabby" condition of the meat. In case of light infection the meat can be used for food after the cysticerci have been rendered harmless, but even in these cases it is well to cut away the most heavily infested portions. Cases of so-called "single infection" should be treated the same as cases of light infection, for although it may unquestionably happen that an animal is infected with but one bladder worm, still the finding of only one parasite is no proof that other parasites are not present; furthermore, in a number of cases of alleged "single infection," later and more thorough examination has revealed further worms.

In case of infection with only very young parasites, in which the suckers are not fully developed, the meat may safely be passed and allowed to go on the market without restriction.

In case of infection with fully developed live bladder worms, the meat should be subjected to some safeguarding method before being placed on the block, or it should be sold under declaration of its exact character.

Opinion differs as to the method which should be followed in case of infection with degenerated bladder worms. It is maintained by some that this meat should be allowed on the market without restrictions. The finding of degenerated cysts, or bladders, however, is no proof that all the parasites are dead, for

not only are cases more or less frequently found in which both live and degenerated bladders are present, but even if the cyst, or bladder, is degenerated the head may, in some cases, still retain its vitality. It is accordingly safer to treat carcasses with degenerated cysts in the same manner as carcasses with live cysts; and should any exception to this be made, such exception should be limited to cases in which the degenerated parasites are found in the muscles of the jaws.

The cysticerci may be killed by cooking, by salting or corning, or by cold storage.

Cooking.—This is the surest method of killing the parasites, but it is open to the serious practical objection that, according to estimates, cooking in a steam sterilizing apparatus results in a shrinkage of from 33 to 50 per cent, and this heavy loss will undoubtedly be a drawback to its general use.

Perroncito found that below 30° C. the movements of the worms are very slight, or practically nil; from 36° to 38° C. the movements are livelier; at higher temperature they diminish, ceasing at 44° C.; they



FIG. 74.—Egg of Beef-measle Tapeworm (*Taenia saginata*), with thick eggshell (embryophore), containing the six-hooked embryo (oncosphere), enlarged. (After Leuckart.)

"die sometimes at 44° C., now and then at 45° C., and always at 46° C." He "therefore concluded that they could in no case survive 47° C. and 48° C. [= 116.6° to 118.4° F.] when they are maintained at this temperature for at least five minutes. Lewis found a somewhat higher temperature necessary in order to kill the worms. He states—

(1) That exposure to a temperature of 120° F. for five minutes will not destroy life in cysticerci, but they may continue to manifest indications of life for at least two or three days after such exposure; (2) that exposure to a temperature of 125° F. for five minutes does not kill them, but (3) after being subjected to a temperature of 130° F. for five minutes they may be considered to have perished. After exposure to this and higher temperatures, in no instance have I been able to satisfy myself that the slightest movements took place in their substance when examined even under a high power. At least, it may be confidently asserted that after exposure for five minutes to a temperature of 135° to 140° F. life in these parasites may be considered extinct.

Pillizzari found that cysticerci died at a temperature of 60° C. (=140° F.), while according to Hertwig 52° C. (=125.6° F.) reduces the bladder worm to a smeary, soft condition, so that it can be easily flattened out between two pieces of glass. It is important to recall, however, that in cooking large pieces of meat the temperature of the inner portion does not rise as rapidly as that of the outer portion. As an index to the duration of cooking required in order to guaranty that all the bladder worms are killed, Ostertag gives the rule of two hours' cooking for pieces of varying length, but not over 12 cm. (=6 inches) thick. Probably the best criterion in forming a judgment is the color of the meat; 60° to 70° C. (=140° to 158° F.) causes a reduction of the haemoglobin, and this results in giving a gray color to beef and a white color to pork; when slices of cooked beef (or pork) assume this gray (or white) color, it can safely be assumed that all the cysticerci have been killed.

In 1894 and 1895 Berlin, Prussia, cooked 342 insured beef-measly carcasses, representing insurance policies to the value of 57,223.30 marks (about \$13,619.15). During the same period there were condemned 221 uninsured beef-measly carcasses, valued, on the same basis, at 36,977.60 marks (about \$8,800.67). The raw beef was sold to the parties having the cooking in charge at 20 pfennige (about 5 cents) per pound, and after being cooked was sold to the public at 30 to 35 pfennige (about 7½ to 8¾ cents) per pound. Cooked measly pork was sold at 40 pfennige (about 10 cents) per pound.

Salting.—Salt solution kills the bladder worms in twenty-four hours, the parasites becoming shriveled. Here, again, it must be remembered that it takes some time for the salt to reach the deeper layers.

It is probable that this method will to some extent supersede the cooking, since the shrinkage by salting is estimated at only 6.6 per cent. Two carcasses of 500 pounds each, treated at Kiel by different methods, form an excellent comparison. The cooked carcass gave 300 pounds of beef which sold at 30 pfennige (about 7½ cents per pound; in

all, 90 marks (about \$21.42); the salted carcass gave 460 pounds of beef which sold at 40 pfennige (about 10 cents) per pound; in all, 184 marks (about \$43.79).

In Saxony measly beef has sold as high as 1 mark (about 24 cents) per pound, while in some parts of Germany it has been sold from $2\frac{1}{2}$ to 10 cents per pound. In a few instances the prejudice against this meat was so great that it could not be sold at all. In general, however, the salted measly beef is easier to dispose of than the cooked measly beef.

Ostertag gives as rule for salting the following: Cut the meat into strips of any given length, but not over 6 cm. (3 inches) in thickness, and place for two weeks in a brine composed of 1,000 parts of water, 250 parts of salt, 20 parts of sugar, and $2\frac{1}{2}$ parts of saltpeter. As a practical test to determine whether the salting is thorough, and the parasites are dead, he suggests the use of a 1 per cent solution of nitrate of silver. If applied to the surface of lightly cured meat this solution will produce no change in the appearance; if the meat is fully cured, a momentary milky opacity will result, owing to the formation of chloride of silver. To use the test, wash the meat thoroughly in water, then wipe it with a cloth, and make a quick incision through the middle of the piece to be tested; apply a few drops of the nitrate of silver to the cut surface.

Cold storage.—Perroncito maintains that *Cysticercus bovis* dies fourteen days after its host has been slaughtered. More recent investigations by Ostertag, Zschokke, Glage, and others have shown that two weeks form too short a limit, but that none of the worms can survive three weeks; beef-measly meat which has been in cold storage for three weeks may therefore be looked upon as harmless.

In view of these recent investigations, I can see no reason why light cases of beef measles (but not pork measles, see p. 94), which have remained three weeks in cold storage, should not be passed as first-class meat and allowed on the open market without further restrictions. During certain seasons of the year, however, there is a practical objection to this method of safeguarding which has been thus far overlooked (except by Friis). Experience has shown that meat which has been in cold storage for this length of time during summer will spoil much more rapidly when taken out of the cooler than meat which has been placed in the ice box only long enough to cool and "firm."

THE ADULT TAPEWORM IN MAN AND METHODS OF PREVENTING THE INFECTION OF CATTLE.

Taenia saginata, or the large Unarmed Tapeworm, is the most common of the ten species of tapeworms found in the intestine of man. A form with which it has frequently been confounded is a tapeworm (*T. solium*) of about half the size (2 to 3.5 m.), acquired by eating pork infected with larvae (*Cysticercus cellulosae*), which are very similar to those found in the cattle, but are somewhat larger and possess a double crown of hooks on the head.

The Unarmed Tapeworm of man is almost cosmopolitan, and is especially common in Africa and Asia. Many of the published statistics of the relative frequency of *T. saginata* and *T. solium* are, however, to be taken with reserve. In some countries the Beef-measle Tapeworm is said to be increasing and the Pork-measle worm to be decreasing in frequency; but in some cases these statements are unquestionably based upon misdeterminations. Physicians too frequently make their determinations upon the external form of the segments—a method which can not be relied upon, even when such determination is made by a specialist. In America, for instance, it is frequently stated that *T. solium* is more common than *T. saginata*, but this view has been shown to be erroneous (Stiles, 1895, p. 281). According to the official medical statistics of the late civil war, 566 cases of tapeworms were noticed in 5,548,854 patients from July 1, 1862, to June 30, 1866, or 1 : 9,803, but no indication as to the species found is given. In some countries statistics seem to show that tapeworm disease has been on the increase. Thus Bérenger-Féraud (1892) records the following statistics for the maritime hospitals of France:

Year.	Cases.	Patients.	Cases per 1,000 patients.
1861-65	33	130,927	0.20
1866-70	95	152,822	0.62
1871-75	422	137,361	3.06
1876-80	1,108	130,898	8.45
1881-85	1,565	155,646	10.05
1886-90	2,253	152,352	14.80

Bérenger-Féraud looks upon 1860 as the date of introduction of *T. saginata* into France, but Blanchard has shown that this is not the case, although he admits that it has increased in frequency from year to year.

Krabbe has published the following valuable statistics regarding tapeworms of man in Denmark:

Year.	<i>T. saginata</i> .	<i>T. solium</i> .	<i>Dipylidium caninum</i> .	<i>Bothriocephalus latius</i> .
Before 1869	37	53	1	9
1869-80	67	19	4	11
1880-87	87	5	4	5
1887-95	89	.....	6	30

It seems quite well established that there has been an increase in the frequency of *T. saginata* in man in some districts, but since Hertwig's important observation in 1889-90 regarding the seats of predilection of the larval stage the destruction of so many more larvae must necessarily have resulted in decreasing the frequency of this species in man. There can be no question that since the trichina scare in 1860 and the following years, which led to an inspection of pork in some countries, and to greater care in cooking it in others, *T. solium* has decreased in frequency.

The following key will aid in the determination of the tapeworms of man:

KEY TO THE ADULT TAPEWORMS OF MAN.

[For forms recorded in this country follow Roman type.]

- (1) Head with two elongate grooves or slit-like suckers; rostellum absent; uterus with special pore; genital pores generally dorsal or ventral.

Bothriocephalidae, 2.

Head with four cup-shaped suckers; rostellum present but not always evident; uterus without special pore; genital pores generally marginal... *Taeniidae*, 4.

BOTHRIOCEPHALIDAE (Subfamily *Bothriocephalinae*).

- (2) Body with external segmentation; head with two elongate or groove-like suckers: Genital organs single in each segment; cirrus, vulva, and uterus open ventro-median *Bothriocephalus*, 3.
Genital organs double in each segment; cirrus, vulva, and uterus open ventrally; worm very large, attains about 10 meters in length by 2 cm. in breadth; life history unknown. Found in Japan *Krabbea grandis*.

BOTHRIOCEPHALUS.

- (3) Very large, attains 10 meters or more in length, reddish gray in color; very rare in this country; obtained from eating fish: Common pike (*Lucius lucius*), ling (*Lota lota*), perch (*Perca fluviatilis*); several members of the salmon family (*Salmo umbla*, *S. trutta*, *S. lacustris*, *Thymallus vulgaris*, *Coregonus lavaretus*, *C. albula*, *Onchorrhynchus Perryi*, and perhaps *Salmo salar*) *B. latus*.
(*B. latus* includes *B. cristatus* Davaine, 1874.)
Length a little less than four feet; found in Greenland *B. cordatus*.
(A larval *Bothriocephalus* (*B. Mansoni*) is found in subperitoneal connective tissue of man.)

TAENIIDAE.

- (4) Egg with thin outer shell and thick brown inner shell (embryophore); uterus median and longitudinal with lateral branches; head generally armed; larval stage a *Cysticercus*, *Coenurus* or an *Echinococcus* generally in herbivora; adults in carnivorous or omnivorous animals *Taeniinae*, 5.
Egg with thin transparent shells, and frequently in egg capsules; in some cases scattered through the segment; head nearly always armed with hooklets on rostellum; larval stage a *cysticercoid*; adults in birds and mammals.
Dipylidiinae, 7.

TAENIINAE.

- (5) Head with armed rostellum 6.
Head unarmed, rostellum absent; strobila attains 3 to 10 meters in length; ovary of pore side undivided; uterus with 17 to 30 branches on each side; the most common tapeworm of man in this country; larva in cattle.
Taenia saginata, p. 71.
(6) Rostellum with two rows of hooks, 24 to 32 in number; strobila attains 4 to 8 meters in length; ovary of pore side divided; uterus with 7 to 12 branches each side; comparatively rare in this country; larva in swine.
T. solium, p. 89.
Rostellum (†)¹; strobila attains 5 meters in length; terminal proglottids 27 to 35 mm. long by 3.5 to 5 mm. wide *T. confusa*.
(The larval stages of *T. solium* and *T. echinococcus* are also found in man.)

¹Ward describes the rostellum as having 6 or 7 rows of very small hooks. Through the kindness of Professor Ward, I have recently examined the head and a number of segments of the original material. This examination leads me to look upon the head as a head of *Dipylidium caninum*, which has accidentally been placed in the wrong bottle, a possibility which had also occurred to Ward. Regarding the remarkable segments, I do not wish to commit myself until I have opportunity to study a complete specimen.

DIPYLIDIINAE.

- (7) Suckers unarmed..... 8.
Suckers armed (the suckers of the young specimens will undoubtedly be found to be armed, although the specimens thus far found in man were unarmed, the hooks probably having fallen), the hooks being arranged in circular rows on border; hooks on rostellum resemble a hammer in form, about 90 in number and arranged in a double row, or rostellum rudimentary and unarmed; strobila 25 to 30 cm. long. Very rare; not yet recorded for America. Larva probably in some invertebrate.
Davainea madagascariensis.
- (8) Genital pores double; two submedian ovaries in each segment; several rows of hooks on rostellum; strobila attains 15 to 35 cm. in length; gravid segments elliptical. Adults found in dogs and cats; rare in man. Larva found in lice and fleas of dogs (*Trichodectes canis* and *Pulex serraticeps*)... *Dipylidium caninum*.
 Genital pores single and unilateral (on left of segment); rostellum with 24 to 30 hooks, the dorsal root longer than prong or ventral root; three testicles normally present in each segment; eggs with three envelopes.... *Hymenolepis*, 9.
- (9) Hooks (24 to 28 in number, 15 μ long) present on rostellum; body 10 to 15 mm. long; not uncommon in Italy; found also in other parts of Europe. Found in rodents (rats, etc.), as well as man; larva develops in the villi of the intestine..... *H. murina*.
 (Including *Taenia nana*.)
 Rostellum rudimentary and unarmed; 20 to 40 cm. or more long; adult generally parasitic in rodents (rats); larval stage develops in certain insects (*Asopia farinalis*, *Anisolabis annulipes*, *Akis spinosa*, *Scarus striatus*).... *H. diminuta*.
 (Including *Taenia flavopunctata*.)

If a person is known to have a tapeworm, it is of great importance, both from an economic (agricultural) and a hygienic standpoint, to know whether one of these two tapeworms (*T. saginata*, the Beef-measle Tapeworm, and *T. solium*, the Pork-measle Tapeworm) is present, and if so, which one. This can be determined in several ways:

(1) Since the Pork-measle Tapeworm comes from pork, it will not be found in persons who abstain from eating that meat, as is usually the case among Hebrews. So that if one of these two parasites were found in such persons it could be only the Unarmed Tapeworm.

(2) On the other hand, those who eat pork but no beef would not be infested with the Unarmed Tapeworm, but we would expect to find in them the Pork-measle (armed) Tapeworm.

These two modes of diagnosis do not hold in all cases, for, as already stated, man is subject to ten different species of tapeworms. Most of the remaining eight species are, however, so totally different from the two under consideration that a positive diagnosis can be made by comparing the worms with figs. 73 and 81, and with the key given above.

(3) When segments of the parasite break off and wander out of their own accord or with stools of the person affected, it should be noticed whether several segments are joined together or whether every portion consists of a single segment. In the former case, the parasite is generally the armed parasite, in the latter case generally the unarmed parasite.

(4) Take a segment of the parasite found in the stool or bed, press it between two pieces of glass and hold it up to the light. Comparing

it with figs. 73 and 81, notice whether the uterus has 17 to 30 branches on each side of the main trunk (Unarmed Tapeworm) or from 7 to 10 branches each side (Armed Tapeworm).

(5) In case the head is found, notice whether hooks are absent (unarmed) or whether two rows of hooks are present (armed).

The necessity of knowing which parasite is present is, first, that the Armed Tapeworm injures man, not only because it inhabits his intestine, but also because the larval stage may develop in the muscles, eye, and other portions of the body, and a man who has the Armed Tapeworm stands in constant danger of infecting himself with these larvae. The Unarmed Tapeworm, on the other hand, develops only in the intestine, its larval form being unable to develop in man.

In the second place, it is important to know which tapeworm is present in a person, especially in a farm hand, for if he has the unarmed form there is constant danger of his infecting the cattle by passing his excrements in fields where cattle feed; if he carries the Armed Tapeworm he will infect the hogs, should he void his excrements in a place to which swine have access.

Symptoms.—The symptoms exhibited by a patient troubled with tapeworms are both general and local: Itching at the extremities of the intestinal canal, and various dyspeptic symptoms; uncomfortable sensations in the abdomen,¹ uneasiness, fullness or emptiness, sensation of movement attributed to the movements of the parasite, colicky pains; disordered appetite, at times deficient, at other times craving; paleness and discoloration around the eyes; fetid breath; sometimes emaciation; dull headache; buzzing in the ears; twitching of the face; dizziness; often the uncomfortable feelings in the intestine are increased by fasting and relieved after a hearty meal; fainting, chorea, epileptic fits.

Diagnosis.—A positive diagnosis can be made by finding the segments of tapeworms in the stools, bed, or clothes of the patient, or by a microscopic examination of the faeces in search of eggs.

Treatment.—It is always advisable to consult a physician in regard to treatment, especially when the patient is much run down in health or naturally delicate in constitution, since "in weak persons, such as those having consumption, the treatment, if admissible at all, must be conducted with the greatest care, lest the patient's strength be exhausted" (Pepper). It is not always possible, however, for men on the ranches to obtain the services of a physician, so the following hints are given in regard to treatment and may be followed without danger by a strong and healthy person of ordinary intelligence:

Before taking any of the medicines suggested below, it is necessary to prepare for the treatment by removing all obstructions in the intestine to the free exit of the parasite. This can best be done by living

¹The most constant symptom which I observed in an experimental infection of myself with *T. saginata* was the sensation which one experiences in the rapid descent of an elevator. This peculiar feeling frequently occurred, especially when walking.

for two or three days on a light diet of milk, coffee, soup, and bread; but vegetables should not be taken. On the evening before taking the medicine it is also advisable to give the patient a thorough injection of 1 to 2 quarts of warm water, to which 1 to 2 tablespoonfuls of pure glycerin may be added.

Early the next morning one of the following doses may be taken:

(1) Take 1 to 2 ounces of oil of turpentine + 1 ounce of castor oil, mixed with the white of an egg and some sugar. Take the whole dose at one time, and if a movement of the bowels does not follow within two or three hours, take another dose of castor oil (1 ounce) (Leidy, 1885).

Objection has been raised by some practitioners to the use of oil of turpentine on the ground that it causes an intense burning sensation in the intestine and produces headaches which may last several days.

(2) The most generally useful remedy is the oleo-resin of male fern,¹ which is in reality an ethereal extract of the drug. A half drachm or drachm of the remedy is given in the morning after two days' restriction of diet, and in the evening a brisk cathartic, such as castor oil, should be administered. Sometimes calomel is given in combination with the oleo-resin. The patient should remain abed after the administration of the remedy, to avoid syncope and other effects of large doses of the drug (Pepper, 1894). In overdose, this medicine is a distinct poison; six drachms have caused death.

(3) One or two ounces of pumpkin seeds ground and made into a paste with sugar. Follow in an hour with a dose of castor oil. This is one of the best, cheapest, and safest tapeworm remedies.

(4) Tanret's Pelletierine is very highly recommended but is rather expensive (\$2.50 per dose) and often difficult to procure fresh in this country. In case this is taken the instructions which come with the bottle (one dose) must be strictly carried out.

Many other remedies could be suggested, but those given above are among the most simple and will suffice for this report.

Whatever anthelmintic is used, the medicine should be procured as fresh as possible. Many failures in treating for parasites are due to the fact that the remedy used has lost its anthelmintic property.

When the parasite is being passed the patient should evacuate into a vessel containing warm water, the object of this being to prevent the worm from breaking or attempting to retain its hold in the intestine in case it is still alive, as it will frequently do if it comes in contact with any cold object. The patient should likewise avoid pulling the worm while it is being expelled, for he is thus liable to break it.

When the movement is completed the stool should be examined thoroughly for the head, for if this has remained in the intestine it will give rise to new segments again, and in about three or four months the patient will discover that he is still infected. If the head is not found upon examination of the stool, it is best not to repeat the treatment until the segments have again appeared, for, as the head is quite small, it may have escaped notice, although present in the stool, and in that case the second treatment would be useless.

Prevention.—After what has been said, it is exceedingly easy to see

¹ Male fern and kamala capsules are put up ready for use. Directions come with each box.

the measures which should be adopted to prevent this disease: (1) Persons should not eat meat in which fresh cysticerci are present; (2) meat in which only a few cysts have been found, but have been cut out, should be thoroughly cooked or salted before eating, or, (3) such beef should lie in cold storage for three weeks at least; (4) cattle and hogs should not have access to human excrements, especially when it is known that persons in the neighborhood have tapeworms; (5) persons should not void their excrements on fields where live stock is feeding.

By following out these simple instructions it will not be a difficult task to totally eradicate the tapeworm disease caused by *T. saginata* and *T. solium* in man, and the corresponding disease of "measles" caused by the larvae of these worms in cattle and hogs. In fact, it has been noticed in several parts of Europe, where meat is inspected, that certain tapeworms are gradually becoming rarer, owing to the condemnation of meat containing the cysts.

20. **Pork Measles** (*Cysticercus cellulosae*) of Man and Swine, and its adult stage, **The Armed, or Pork Measle, Tapeworm** (*Taenia solium*) of Man.

[Figs. 75-83.]

Many authors state that the Pork-measle Tapeworm is the common tapeworm of man for the United States, but a careful study of the subject has shown this view to be erroneous.

LARVA (*Cysticercus cellulosae*).

For anatomical characters, compare figs. 75 and 76 with key, p. 21.

SYNONYMY.—*Finna* Werner, 1786; *Taenia hydatigera* Fischer, 1788; *T. cellulosae* Gmelin, 1790; *T. finna* Gmelin, 1790; *Vesicaria hygroma humana* Schrank, (?-); *V. finna suilla* Schrank, (?-); *V. lobata suilla* Fabricius, (?-); *Hydatis finna* (Werner) Blumenbach, (?-); *H. humana* Blumenbach, (?-); *Taenia muscularis* Jördens, 1802; *T. hydatigena anomala* Steinbuch, (1802); *Cysticercus finna* (Gmelin) Zeder, 1803; *C. cellulosae* (Gmelin) Rudolphi, 1808; *C. finnus* (Gmelin) Laennec, 1812; *C. solium* Koeberlé, 1861; *C. suis* Cobbold, 1869; *Neotaenia* Sodero, (1886); *C. cellulosus* of several authors; "*Cysticercus*" *cellulosae* of Schneidemühl, 1896.

ANOMALIES.—The names proposed by various authors for these supposed distinct species found in man, especially in the cranial cavity, are more or less descriptive. *Hydatis piriformis* Fischer, 1789 (= *Taenia pyriformis* (Fischer) Treutler, 1793 = *Cysticercus pyriformis* (Treutler) Zeder, 1803 = *C. Fischerianus* Laennec, 1812); *Taenia albopunctata* Treutler, 1793 (= *C. albopunctatus* (Treutler) Zeder, 1803 = "*T. albopunctata hominis* Treutler" of Cobbold, 1864); *Cysticercus dicystus* Laennec, 1812; *C. acanthotrias* Weinland, 1858; *C. turbinatus* Koeberlé, 1861; *C. melanocephalus* Koeberlé, 1861; *C. racemosus* Heller, 1875 (= *C. bothryoides* Heller, 1875 [nec Reinitz, 1885] = *C. multilocularis* Küchenmeister, (?-); *Trachelocampylus* Davaine, 1880 (for *Trachelocampylus* Fredault, 1847).

HOSTS.—Man, swine, wild boar, and other animals. (See pp. 137-143.)

ADULT (*Taenia solium* Linnaeus, 1758).

For anatomical characters, compare figs. 77-81 with key, p. 84.

SYNONYMY.—*Taenia solium* Linnaeus, 1758 (after elimination of *T. saginata* and *T. marginata*); *T. cucurbitina* Pallas, 1766 (= *T. solium* Linnaeus, renamed); *T. cucurbitina* Art [= var.] *pellucida* Goeze, 1782; *T. cucurbitina, plana, pellucida* Goeze,

1782; *T. solitaria* Leske, (1785), pro parte; *Halysis solium* (Linnaeus) Zeder, 1803; *Taenia humana armata* Rudolphi, 1810, pro parte (= Brera's, 1802, *Tenia armata umana*); *T. solium* Linnaeus of Küchenmeister, 1852; *T. hamoloculata* Küchenmeister, 1855 (possibly earlier); *T. turbinata* Koeberlé, 1861; *T. (Cystotaenia) solium* of Leuckart, 1863; *T. tenella* Cobbold, 1874 [nec Pallas, 1781]; (?) *T. solium* var. *minor* Guzzardi Asmendo, 1876; *T. officinalis* Bos, 1894.

ANOMALIES.—(?) "*Taenia vulgaris*" Werner, 1782 [nec Linnaeus, 1758] = *T. dentata* Batsch, 1786; (?) *T. fenestrata* Chiaje, 1833; *T. (Cysticercus) acanthotrias* of Leuckart, 1863; (?) *T. fenestrata* Colin, 1885; *T. solium fenestrata* Colin, 1876; (?) *T. fusa*, *T. continua*, *T. solium fusa* seu *continua* Colin, 1876; (?) *T. scalariforme* Notta, 1885 (= *T. fenestrata* Colin, renamed) = *T. solium scalariforme* Notta, 1885.

PRE-LINNAEAN NAME.—(?) *Taenia degener* Spigelius, 1618.

BIBLIOGRAPHY.—For bibliography, see Huber, 1892. For technical discussion, see Leuckart (1880, pp. 617-713); R. Blanchard (1886, pp. 382-418).

HOST.—Man. It is an error for the Minnesota State board and the North Carolina Station to record it in dogs.

Life history.—The life cycle of the Pork Bladder Worm is exactly the same as that of the Beef Bladder Worm (see p. 72), except that the hog is the intermediate host.

The following observations regarding the larval parasite at different ages have been made by various authors:

Nine days after infection.—An oval vesicle 33 μ long by 24 μ broad; connective tissue cyst absent. (Mosler.)

Twenty days after infection.—Parasite consists of a delicate, transparent bladder worm about as large as the head of a pin. The anlage (primordium) of the head is represented by a small, indistinct point; surrounding cyst absent. (Gerlach.)

Twenty-one days after infection.—Spherical, 0.8 mm. in diameter; slightly attenuate toward the point, showing the anlage (primordium) of the head. (Leuckart.)

Thirty-two days after infection.—Ellipsoid, 1 mm. to 6 mm. long by 0.7 mm. to 2.5 mm. broad. The largest specimens show the excretory system; the anlage (primordium) of the head equatorial; connective tissue cyst very thin.

Forty days after infection.—Surrounding cyst still very

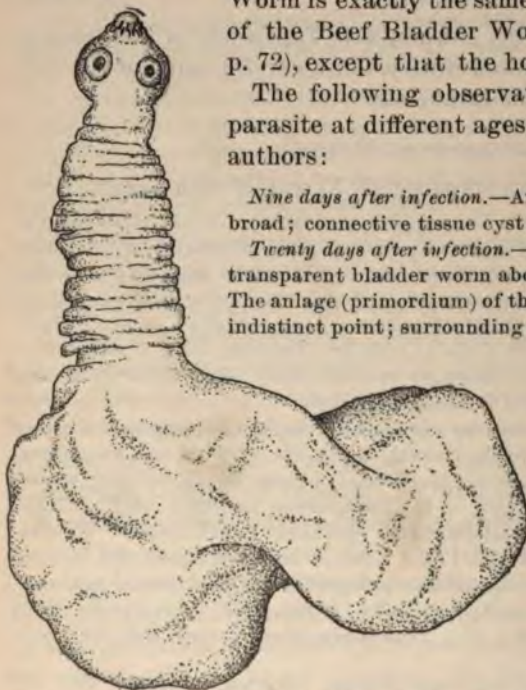


FIG. 76.—An isolated Pork-measle Bladder Worm (*Cysticercus cellulosae*), with extended head, greatly enlarged (original).

delicate; about as large as a mustard seed, or somewhat larger; head very evident, suckers and hooks visible, but not complete. (Gerlach.)

Sixty days after infection.—Size of a pea or slightly larger. When freed from the connective tissue, cyst somewhat renal in form; head as a small, white knob, but without neck; hooks and suckers fully developed. (Gerlach.)



FIG. 75.—A piece of pork heavily infested with pork measles (*Cysticercus cellulosae*), natural size (original).

One hundred and ten days after infection.—Neck developed; transverse lines slightly visible; head is invaginated in the bladder. (Gerlach.)

The determination of the age of the parasite is of importance in case that there is a guaranty of freedom from infection. According to Rasmussen the periods of guaranty are: In Prussia, Bavaria, and Austria, 8 days; in certain other parts of Europe, 9, 15, and 21 days; in Baden and Württemberg, 28 days, and in Saxony, 30 days.

It is generally estimated that three to four months are required for the parasite to complete its development, but as the hooks and suckers are formed after two and a half months it is not impossible that a parasite ten to eleven weeks old would develop into the adult tapeworm if eaten by man; although, according to Gerlach, pork measles less than two months old are not dangerous. The longevity of the bladder worm varies with circumstances, but the factors here concerned are not understood. According to Railliet, cases have been observed in man where the bladder worm has caused severe cerebral troubles for twelve to fifteen years, and it has been observed in the eye for twenty years. The worms may undergo calcareous degeneration very early, but as a rule this does not take place until the cyst is quite old.

The degeneration begins with the capsule and ends with the scolex, and, according to Morot, may be divided into four stages, as follows:

First stage.—The capsule shows cheesy, opaque spots, but the fluid is clear, and the scolex is intact.

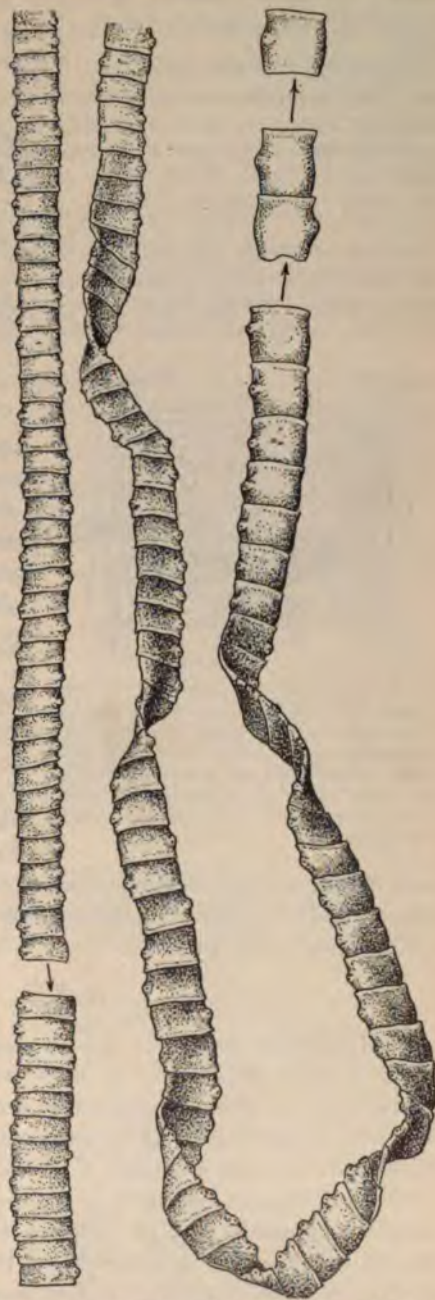


FIG. 77.—Several portions of an adult Pork-measle Tape worm (*Taenia solium*), natural size (original).

Second stage.—Both the connective tissue capsule and the bladder cyst become cheesy; hooks are present, but the suckers more or less degenerated.

Third stage.—Hooks are present, but not in definite order or number.

Fourth stage.—No traces of the hooks can be found in the parasite, which is reduced to a cheesy mass.

Ostertag states that degeneration may take place before the hooks have formed. Ostertag has also shown that the hooks become loose, upon expression of the scolex, only in dead bladder worms.



FIG. 78.—Large (a) and small (b) hooks of Pork-measle Tapeworm (*Taenia solium*). $\times 280$. (After Leuckart, 1880, p. 661, fig. 293.)

PORK MEASLES.

The disease in hogs.—The symptoms in hogs are very indefinite, but a diagnosis may sometimes be made by examining the visible mucous membranes of the mouth, particularly under the tongue. See also the same subject for cattle, p. 77.

A heavy infection of measles is more common in hogs than in cattle—a fact easily understood when we recall the feeding habits of the two animals, the comparative size of their bodies, and of their stomachs. From 1884 to 1887, of 5,610 measly

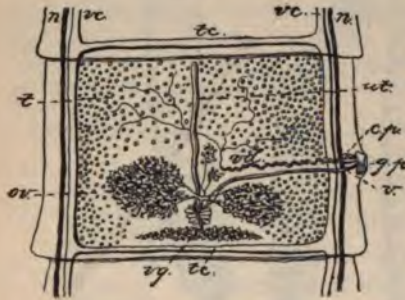


FIG. 79.—Mature sexual segments of Pork-measle Tapeworm (*Taenia solium*), showing the divided ovary on the pore side: cp, cirrus pouch; gp, genital pore; n, nerve; ov, ovary; t, testis; tc, transverse canal; ut, uterus; v, vagina; vc, ventral canal; vd, vas deferens; vg, vitelline gland. $\times 10$. (After Leuckart, 1880, p. 665, fig. 294.)

hogs found at the Berlin (Prussia) abattoir, 2,167 were heavily infested, 1,641 had medium infections, and 1,802 were slightly infested.

Treatment.—See page 77.

ABATTOIR INSPECTION.

See discussion, page 77. As the Armed Tapeworm is more dangerous to man than the unarmed form, the abattoir inspection for *Cysticercus cellulosae* is more important from a hygienic standpoint than the inspection for *C. bovis*.

Position of the parasites in hogs.—The Pork-measle Bladder Worm is found in the muscles, especially in the abdominal muscles, the muscular portion of the diaphragm, the psoas, tongue, heart, the muscles of mastication, intercostals, muscles of the neck, the adductor of the hind legs, and the pectorals. These parts are shown by fig. 83. Particular stress should be laid



FIG. 80.—Segment of Pork-measle Tapeworm (*Taenia solium*) in which the uterus is about half developed. $\times 2$. (After Leuckart, 1880, p. 666, fig. 295.)

upon an examination of the tongue and muscles of mastication, the muscles of the shoulder, neck, and diaphragm.

The parasite of hogs which is most liable to be mistaken for *C. cellulosa* is the large bladder worm with a long neck (*C. tenuicollis*, p. 96). The latter form, which is not transmissible to man, occurs under the serous membranes of the body cavities, but is not found in the muscles; it is much larger, and is provided with more hooks (28 to 40) than *C. cellulosa* (22 to 28).

Frequency of Cysticercus cellulosa in hogs.—Satisfactory statistics regarding the presence of this parasite in American hogs are lacking; we know, however, the American hogs are comparatively free from this worm. The statistics for Prussia are quite complete, the proportion of infested hogs being as follows:

1876 to 1882.—One hog infested in every 305 hogs examined. (Johne, after Ostertag.)

1886 to 1893.—One hog infested in every 637.5 hogs examined.¹

The proportion of measly hogs appears to vary in different localities. Thus at the Berlin abattoir the average for seven years was 1 infested hog to every 173 hogs examined (Ostertag). In south Germany the parasite is said to be rare. It is much more common in the eastern Prussian provinces than in the western, as shown by Ostertag in the following statistics for 1892:

Regierungsbezirk.	Proportion.	Regierungsbezirk.	Proportion.
Marienwerder.....	1:28	Arnsberg.....	1:865
Oppeln.....	1:80	Coblenz.....	1:975
Königsberg.....	1:108	Düsseldorf.....	1:1070
Stalsund.....	1:187	Münster.....	1:1900
Posen.....		Wiesbaden.....	
Danzig.....	1:250	Entire Prussia.....	1:1290
Frankfurt.....		Eastern provinces.....	1:604
Bromberg.....			

The hogs imported into Germany from Russian Poland, Galicia, Bohemia, and Siberia were infested in much higher proportion than the German hogs; in some of the importations the proportion ran as high as 50 per cent (Ostertag).

¹ The totals of the following table do not agree with the totals published in Germany, but are made upon the details given for the various years. Several errors in addition were noticed in the German statistics.

Year.	Hogs inspected.	Hogs infested with <i>C. cellulosa</i> .	Authority.
1880.....	4,834,898	10,126	Veröff. d. kais. Gesundheitsamtes, 1891, p. 244.
1887.....	5,486,416	11,068	
1888.....	6,051,249	10,031	
1889.....	5,500,678	8,373	Veröff. d. kais. Gesundheitsamtes, 1894, p. 208.
1890.....	5,590,512	5,492	
1891.....	6,550,182	7,689	
1892.....	6,134,559	9,364	Veröff. d. kais. Gesundheitsamtes, 1895, p. 347.
1893.....	6,251,776	10,640	
Total.....	46,400,272	72,783	

Influence of the age of the host.—According to Gerlach hogs over six months old will not become infested with this parasite, but this is not admitted by Fischöder.

Disposition of measly pork.—See disposition of measly beef, p. 81. Since *Taenia solium* is more dangerous than *T. saginata*, the regulations concerning the disposition of measly pork should be even more rigid

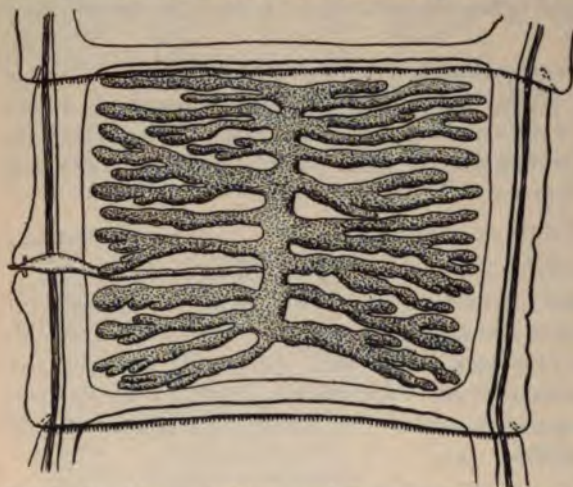


FIG. 81.—Gravid segment of Pork-measle Tapeworm (*Taenia solium*), showing the lateral branches of the uterus, enlarged (original).

than those concerning measly beef. Pork of this character can of course be sold under declaration, but even this is not advisable unless the meat is first rendered non-infectious. Cases of so-called "single infection"¹ should be treated the same as cases of moderate infection. In very heavy infections (up to 20,000 bladder worms may occur in a single carcass) the

pork is watery and pale; it decomposes easily, and has a disagreeably sweet taste. Such cases should, of course, be condemned to the tank.

Cooking.—According to Perroncito, *C. cellulosae* dies at 45° to 50° C. (= 113° to 122° F.). (See also p. 81.) It dies in 1 minute at 50° C.

Storage.—Living specimens of *C. cellulosae* have been found in pork twenty-nine days after slaughtering (Railiet). After fourteen to nineteen days of cold storage at -10° to -15° C. the parasites are said to be dead; the protoplasm has become viscid, bluish opaque, and the hooks have fallen. More observations are needed upon this subject.

Effects of electricity.—Glage has experimented some with electricity in order to kill the parasite of pork measles, but further study in this line is desirable before the method is adopted.



FIG. 82.—Eggs of Pork-measle Tapeworm (*Taenia solium*): a, with primitive vitelline membrane; b, without primitive vitelline membrane, but with striated embryo. $\times 450$. (After Leuckart, 1880, p. 667, fig. 297.)

THE ADULT AND LARVAL TAPEWORM IN MAN.

See discussion, page 83. It should always be recalled that the Armed Tapeworm is more dangerous than the Unarmed Tapeworm, since, as already stated, the larva as well as the adult may develop in man.

¹ During the year 1889-90 Berlin, Prussia, found 373 cases of alleged single infection; of these, 56 cases were afterward shown to contain more than one parasite.

Treatment.—See page 87.

Cysticercus cellulosae in man.—This infection may take place in different ways; a patient may either soil his hands with the microscopic eggs during defaecation and afterward swallow the eggs; or, through a reverse peristaltic movement of the intestine, gravid segments may be carried into the stomach, where the shells will be destroyed, thus freeing the embryos. An infection through a contaminated water supply may also take place. (See Life history, p. 90.) In man the bladder worm may develop in the muscles, the eye, and the brain.

The following statistics upon the distribution of the worm in various parts of the body have been compiled from different sources:

Locality.	Parasite found in—						Total number of cases.	Authority.
	Brain.	Muscles.	Heart.	Lungs.	Under skin.	Liver.		
Dresden	21	11	3				22	Müller.
Erlangen		1					14	
Berlin	72	13	6	3	3	2	87	Dressel.
Erlangen	13	6			2		21	Haug (1874-1886).
(?)	6	1					6	Gribbohm.
(?)	5						5	Sievers.
Total	117	32	9	3	5	2	155	

The following statistics refer to the presence of this parasite in the eye:

Locality.	Total number of patients or bodies.	<i>C. cellulosae</i> in the eye.	Authority.
Berlin	80,000	50	von Gräfe.
Berlin	60,000	70	Hirschberg (1890-1895).
Berlin	30,000	1	Hirschberg (1896-1899).
Berlin	43,000	2	Hirschberg (1890-1894).
France	60,000	1	De Wecker
Austria	30,000	7	Mauthner
			Parasite in crystallin lens.

According to Virchow, the proportion of cysticercus in the human cadavers dissected in Berlin has been reduced from 1:31 (before the introduction of meat inspection) to 1:280 (since the introduction of meat inspection).

The following statistics, collected from various sources by Blanchard, refer to post-mortem examinations:

Locality.	Number of post-mortems.	Number infected.	Proportion infected.
Switzerland:			<i>Per 1,000.</i>
Zürich	2,500	1	2.5
Basel	1,100	0	0
Basel	1,914	6	1.13
Germany:			
Kiel			6
Erlangen			6.7
Dresden			11.3
Berlin			16.4
Berlin			12.5

Prevention.—See page 88.

21. The Thin, or Long, Necked Bladder Worm (*Cysticercus tenuicollis*) of Cattle, Sheep, and Swine, and its adult stage, The Marginate Tapeworm (*Taenia marginata*) of Dogs and Wolves.

[Figs. 84-87A, 88, 89B, 90-93]

Still another bladder worm, which is by no means uncommon in the animals of this country, occurs in the body cavity of cattle, sheep, swine, and other animals, attached to the diaphragm, omentum, liver, or other organs.

When eaten by dogs or wolves, it develops into the Marginate Tapeworm, which was formerly confused with *T. solium* of man, and gave rise to the erroneous idea that the Pork-measle Tapeworm occurs in dogs as well as in man.



FIG. 83.—Half of hog, showing the portions most likely to become infested with pork measles. (After Ostertag, 1895, p. 387, fig. 79.) See p. 92.

LARVAL STAGE (*Cysticercus tenuicollis*).

For anatomical characters, compare fig. 84 with key, p. 21.

SYNONYMY.—*Taenia hydatidea* Pallas, 1760; *T. hydatigena* Pallas, 1766, pro parte; *Hydra hydatula* Linnaeus, (1766); *Vermis vesicularis eremita* Bloch, 1782; *Hydatigena orbicularis* Goeze, 1782; *H. globosa* Batsch, 1786; *H. oblonga* Batsch, 1786; *Vesicaria orbicularis* Schrank, 1788; *Taenia simiae* Gmelin, 1790; *T. ferarum* Gmelin, 1790; *T. caprina* Gmelin, 1790; *T. orilla* Gmelin, 1790; *T. vervecina* Gmelin, 1790; *T. bovina* Gmelin, 1790; *T. apri* Gmelin, 1790; *T. globosa* (Batsch) Gmelin, 1790; *Hydatula solitaria* Viborg, (1795); *Cysticercus claratus* Zeder, 1803; *C. simiae* (Gmelin) Zeder, 1803; *C. caprinus* (Gmelin) Zeder, 1803; *C. tenuicollis* Rudolphi, 1810; *C. riscalis simiae* Rudolphi, 1810 (*T. simiae* Gmelin, renamed); *C. lineatus* Laennec, 1812; *C. oris* Cobbold, 1865; *Monostomum hepaticum suis* Willach, 1893; "*Cysticerkus*" *tenuicollis* of Schneidemühl, 1896.

PRE-LINNAEAN NAMES.—*Hydatides* Bartholini, 1673; *Vermes vesiculares* Hartmann (1685), quoted by Pallas as *Hydatis animata*; *Lumbricus hydropicus*, Tyson, 1691.

HOSTS.—Cattle, sheep, swine, deer, and other animals. (See pp. 137-143.)

ADULT STAGE (*Taenia marginata* Batsch, 1782).

For anatomical characters, compare figs. 85-89 with key, p. 101.

SYNONYMY.—See also pp. 89-90. *Taenia solium* Linnaeus, 1758, pro parte; *T. cateniformis* Goeze, 1782, pro parte; *T. marginata* Batsch, 1782; *T. lupina* Schrank, (1788); *T. cateniformis* β . *lupi* Gmelin, 1790; *Halysis marginata* (Batsch) Zeder, 1803; also "*T. solium*" of dogs, of several medical authors.

BIBLIOGRAPHY.—For technical discussion, see Deffke, 1891.

HOSTS.—Dog and wolf. (See pp. 137-143.)

Life history.—In tracing the life history it is best to begin with the



FIG. 84.—The Thin-necked Bladder Worm (*Cysticercus tenuicollis*), with head extruded from body, from cavity of a steer, natural size (original).

egg, produced by the adult tapeworm in the intestine of dogs. These eggs, containing a six-hooked embryo, escape from the dog with the excrements and are scattered on the ground, either singly or confined in the escaping segments of the tapeworm. Once upon the ground they are easily washed

along by rain into the drinking water, ponds, or brooks, or scattered on the grass. Upon being swallowed with fodder or water, they arrive in the stomach of the intermediate host (cattle, sheep, etc.), where the eggshells are destroyed and the embryos set free. The embryos then traverse the intestinal wall, and according to most authors arrive either actively, by crawling, or passively, by being carried along by the blood, in the liver or lungs, where they undergo certain transformations in structure. While still in the finer branches of the blood vessels of the liver, which they transform into small irregularly shaped tubes about 12 to 15 mm. long and 1 to 1.5 mm. broad, the embryos lose their six hooks, and develop into small round kernels, which are generally situated at one end of the tubes. The embryo can first be seen about four days after infection. The "scars" (figs. 91 and 92) described in the liver of animals infested with *Cysticercus tenuicollis* are nothing more nor less than these tubes, or altered blood vessels, caused by the growth and wandering of the parasites. In a shoat which Leuckart infected with eggs, and which he killed twenty-three days after the infection, he found two young cysticeri in the liver 6 to 8.5 mm. long and 3.5 to 5 mm. broad. In the smaller parasite no head was visible; in the larger, one end was slightly differentiated and evidently represented the anlage (primordium) of the

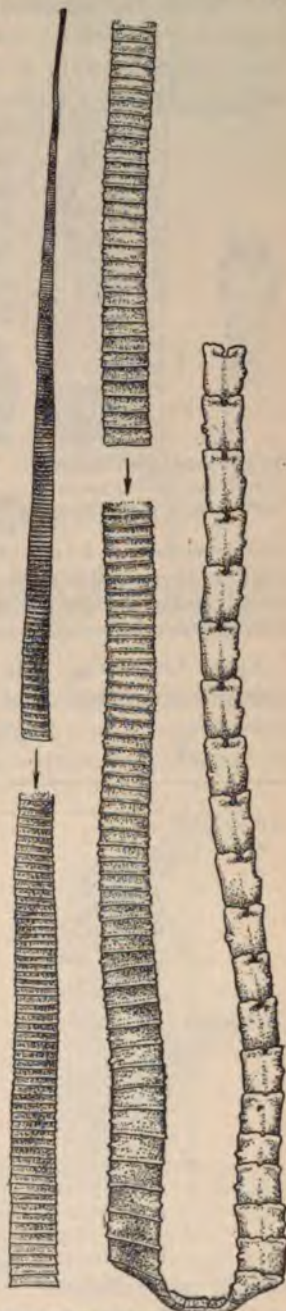


FIG. 85.—The Marginate Tapeworm (*Taenia marginata*), natural size (original).

scolex—that is, the head and neck in course of development. The portion which was destined to give rise to the head and neck was a small projection extending into the cavity of the hydatid. At about this stage, or a few days later, the parasites leave the liver, fall into the body cavity, and become encysted again in the organs mentioned above.



FIG. 86.—Head of the Marginate Tapeworm (*Taenia marginata*). $\times 17$. (Original.)

A month after infecting another shoat, Leuckart found cysticerci in the body cavity, with partially developed suckers and hooks. Six weeks after the infection of another shoat, he found cysticerci 15 mm. long encysted in the omentum, and with fully developed scolex. Three months after infecting a lamb, he found cysticerci twice as large. Experiments have also been made by other authors (Baillet, Küchenmeister, Railliet, etc.), most of them agreeing with Leuckart's experiment.

Curtice, however, takes a somewhat different view, that is, he considers the liver as a place of destruction for the young parasites, rather than a normal place for their development; he also claims that the embryos which may even travel the entire length of the intestine of the intermediate host, traverse the intestine and arrive directly in the position where they complete their larval development without first passing through the liver.

After developing into the full-grown bladder worm, the parasites remain unchanged until they are devoured by a dog or wolf, or until,



FIG. 87.—Small and large hooks of (A) *Taenia marginata*, (B) *T. serrata*, and (C) *T. coenurus*: a, small hooks; b, large hooks. $\times 480$. (After Deffke, 1891, Pl. II, fig. 9.)

after an undetermined length of time, they become disintegrated and more or less calcified.

If the hydatid is devoured by a dog or wolf, either when the latter prey upon the secondary host or when the dog obtains the cyst at a slaughterhouse, the bladder portion is destroyed, the scolex alone remaining

intact in the digestive fluids. The head holds fast to the intestinal wall with its suckers and hooks; by strobilation (transverse division) it

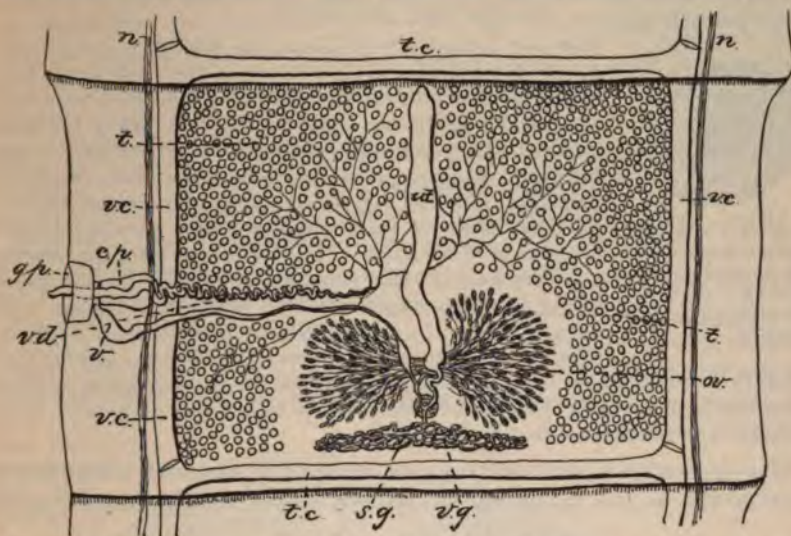


FIG. 88.—Sexually mature segment of the Marginate Tapeworm (*Taenia marginata*): *cp*, cirrus pouch; *gp*, genital pore; *n*, nerve; *ov*, ovary; *sg*, shell gland; *t*, testicles; *tc*, transverse canal; *ut*, uterus; *v*, vagina; *vc*, ventral canal; *vd*, vas deferens; *vg*, vitellogene gland. Enlarged. (After Deffke, 1891, Pl. I, fig. 1.)

gives rise to the segments, which, as we have already seen, together with the head, go to make up the adult tapeworm. Reproductive organs of both sexes develop in the separate segments, and eggs are

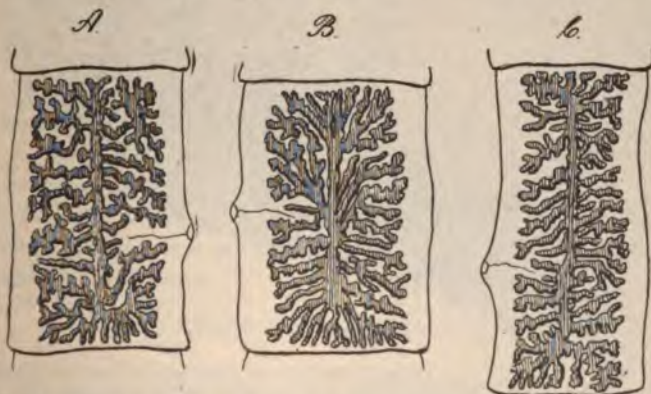


FIG. 89.—Gravid segments, showing the lateral branches of the uteri of (A) *Taenia serrata*, $\times 4$; (B) *T. marginata*, $\times 6$; (C) *T. coenurus*, $\times 10-15$. (After Leuckart, 1880, p. 720, fig. 308.)

produced within which are developed the six-hooked embryos, the point from which we started out.

The disease in cattle, sheep, and hogs.—As a rule, this bladder worm is a comparatively harmless parasite, a light infection having little or no

effect upon the host. A heavy infection may, however, prove fatal to young animals.

So far as I know, only one case is on record where this parasite has proven fatal to cattle—probably from the fact that no severe infections have yet been found; and



FIG. 90.—Egg of the Marginate Tapeworm (*Taenia marginata*) with six-hooked embryo, greatly magnified (original).

from our present knowledge of the subject, it can be confidently asserted that a slight infection has little or no effect upon this host. In experiments which have been made upon sheep and pigs, it has been noticed that heavy infections have not only produced decided symptoms but have proved fatal to the animals named. Several cases (Leuckart, Zachokke, Railliet) are also reported where pigs have died from the effects of these parasites which were accidentally acquired with their food. In all of these cases the infection was very heavy. The parasites had caused peritonitis and pleurisy by their migrations from the liver and lungs to the body cavities. In a case recently described by Railliet, a shoat of two months succumbed to the disease. Baillet made

numerous experiments on lambs and on young goats, the animals dying in ten to fifteen days (a primordium of the scolex was noticed on cysts fifteen days old). In one of Railliet's experiments a goat died in five days.

There is no way of positively diagnosing when an animal is infested with these larvae, as the symptoms noticed on experimental animals apply



FIG. 91.—Portion of the liver of a lamb which died nine days after feeding with eggs of the Marginate Tapeworm (*Taenia marginata*), with numerous "scars," due to young parasites. (After Curtice, 1890, Pl. X, fig. 1.)

equally well to other infections. Diagnosis being uncertain or even impossible, it is useless to discuss treatment, except to remark that the parasite can not be reached with medicines; so that any treatment advised would be simply that advocated for pleurisy or peritonitis.

Prevention is a comparatively easy matter and lies in keeping dogs free from tapeworms.

ABATTOIR INSPECTION.

So far as the question of using beef, mutton, or pork from animals infested with *Cysticercus tenuicollis* as food for man is concerned, this parasite is of no importance whatever; for although several authors have attempted to infect themselves with tapeworms by swallowing this larva, all such experiments have been negative.

Differential diagnosis.—Infection of cattle, sheep, and hogs by *C. tenuicollis* may be mistaken for infection by *C. bovis* (p. 71), *C. cellulosae* (p. 89), *Echinococcus* (p. 113), and even for *tuberculosis*, but the differential diagnosis should not be difficult. For the differences between the Long-necked Bladder Worm and the other three larvae, see the discussions of those parasites. The condition of the corresponding lymphatic glands in *tuberculosis* of the host, as well as the hooks and calcareous

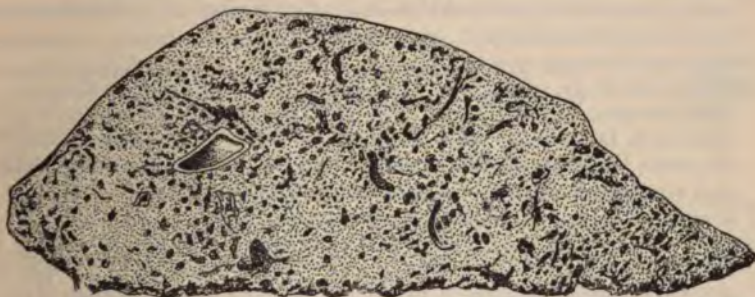


FIG. 92.—Cross section of the liver of a lamb which died nine days after feeding with eggs of the Marginate Tapeworm (*Taenia marginata*). (After Curtice, 1890, Pl. X, fig. 2.)

corpuscles of *C. tenuicollis*, allow a differentiation of degenerated and calcified specimens of this parasite from *tuberculosis*.

Frequency of C. tenuicollis.—In some countries the larval stage is common, especially in sheep. Olt found it in 26.4 per cent of the sheep (132 times in 500 sheep) examined at Stettin, Germany. It occurs in America, Europe, Africa, and probably elsewhere.

In connection with this parasite it is necessary to consider the adult tapeworms found in dogs.

THE ADULT TAPEWORMS OF DOGS.

The Marginate Tapeworm is unfortunately not the only tapeworm in the dog which proves harmful to our flocks. The following key will aid in determining the most common canine forms and show the source of infection:

KEY TO THE ADULT TAPEWORMS OF DOGS.

[For the forms transmissible to cattle, sheep, and swine follow Roman type.]

- (1) Four suckers on the head..... Family *Taeniidae*, 2.
 Two suckers on the head; genital pores ventro-median..... *Bothriocephalus*.

- (2) Head armed with hooks; genital pores marginal..... 3.
Head not armed with hooks; genital pores ventro-median..... Mesocotoides.
- (3) Head armed with a double row of hooks; genital pores on only one side of each segment..... 4.
Head very small, with about 60 hooks arranged in 4 rows; body 10 to 40 cm. long, with 80 to 120 quadrate to elliptical segments, the largest of which may measure 1.5 to 3 mm. broad by 8 to 10 mm. long; eggs in round capsules, about 250 in number, with 5 to 20 eggs in each capsule; eggs measure 43 to 50 μ ; larval stage in fleas and lice, which may transmit the worm to dogs or to man..... Dipylidium caninum.
- (4) Body small, 4 to 5 mm. long, with only 3 to 4 segments, the largest of which may measure 0.6 mm. broad by 2 mm. long; 28 to 50 hooks on the head; about 60 testicles present in a segment; embryophores 32 to 36 μ by 25 to 30 μ . The eggs are transmissible to man, oxen, sheep, pigs, horses, and other mammals, and develop into the larval stage (the Echinococcus hydatid), which is very dangerous. All dogs found infested with this worm should be killed and burned..... *Taenia echinococcus*, p. 113.
 Body much larger and with many more segments..... 5.
- (5) Segments somewhat broader than long, or square, or longer than broad..... 6.
Segments much broader than long, except the distal segments which suddenly elongate; head small, with 26 to 34 hooks; genital pore unusually large and prominent; embryophores 30 μ . Larval stage develops in the reindeer..... Taenia Krabbei.
- (6) Ventral root of hooks simple..... 7.
Ventral root of smaller hooks bifid..... 8.
- (7) Strobila 40 to 60 cm. long, rarely 1 m.; head pyriform, 0.8 mm. in diameter, with 22 to 32 hooks, the larger hooks 150 to 170 μ long; 220 to 250 segments present; distal 12 to 15 segments measure 8 to 12 mm. long by 3 to 4 mm. broad; 18 to 26 uterine branches (fig. 89 C) each side of median stem; about 200 testicles in each segment; embryophores spherical, 31 to 36 μ . Transmissible from dogs to lambs and calves, in which animals it causes "Gid"..... *Taenia coenurus*, p. 103.
 Strobila 1.5 to 5 m. long; head renal to square, 1 mm. broad, with 28 to 44 hooks, the larger hooks 188 to 220 μ long; 650 to 700 segments present; distal 50 to 70 segments measure 10 to 14 mm. long by 4 to 7 mm. broad; 5 to 6 or 8 uterine branches (fig. 89 B) each side of median stem; about 600 testicles in each segment; embryophores spherical, 31 to 36 μ . Transmissible from dogs to cattle, sheep, swine, etc..... *Taenia marginata*, p. 96.
- (8) Strobila 45 to 72 cm. long; head globular, 0.85 to 1.3 mm. in diameter, with 26 to 32 hooks, the larger of which measure 135 to 156 μ long; largest segments 8 to 16 mm. long with prominent posterior edge; embryophores ovoid, 33 to 41 μ by 26 to 31 μ . Transmissible to rabbits and hares..... *Taenia serialis*.
 Strobila 60 cm. to 2 m. long; head 1 to 3 mm. in diameter, with 33 to 43 hooks, the largest measuring 225 to 250 μ long; about 400 segments present, of which the distal 30 to 40 measure 10 to 17 mm. long by 4 to 6 mm. broad; posterior edge of segments very prominent, giving strobila a serrate appearance; about 400 testicles in each segment; uterus with 8 to 10 lateral branches (fig. 89 A) each side of median stem; embryophores ovoid, 36 to 40 μ by 31 to 36 μ . Transmissible to rabbits and hares..... *Taenia serrata*.

Tapeworm disease in dogs.—It is the exception that the presence of tapeworms in dogs is diagnosed symptomatically, since in the majority of cases, especially in light infections, these parasites do not affect dogs to such an extent as to attract attention. Many a house dog or hunting dog harbors tapeworms without their presence ever being suspected. In some cases, however, the worms cause more or less serious pathological lesions in the intestine, which naturally bring about

pronounced symptoms, although the direct cause of the trouble is not always apparent to the diagnostician.

The general symptoms exhibited are a change in appetite, disposition to vomit, general restlessness, occasionally cramps.

The smaller species of tapeworms, *Taenia echinococcus* and *Dipylidium caninum*, have been accredited with doing more harm than the larger forms (*T. marginata*, *T. serrata*, *T. coenurus*, and *T. serialis* and *Bothriocephalus*). A heavy infection of *T. echinococcus* may cause a severe, in some cases fatal, intestinal inflammation, with hemorrhage, the dog exhibiting epileptic symptoms or even symptoms which might be mistaken for hydrophobia—change of voice, tendency to bite, weakness, paralysis of lower jaw, etc. *Dipylidium caninum* occasionally bores tunnels in the mucosa of the intestine “through which the strobila is drawn, much like a train of cars.” Schieferdecker found a peculiar hypertrophy of the intestinal villi in a dog infested with this parasite, the villi being four to five times the normal length; the glands of Lieberkühn were more or less atrophied. The same severe symptoms mentioned for infection with *T. echinococcus* have also been noticed in dogs infested with *D. caninum*. An accumulation of tapeworms may result in a stoppage of the bowels, and cases are on record of perforation of the intestinal wall by *T. serrata*.

The nervous symptoms are more pronounced in high-strung dogs. Regarding frequency, it may be stated that tapeworms are more common in butchers' dogs and stray dogs having access to slaughterhouses than in other dogs. It is claimed by some authors that male dogs are more frequently infested than female dogs, and that tapeworms are more common in large dogs and in dogs from 1 to 3 years old than in small dogs and animals under 1 year of age.

The best method of diagnosis is to examine the faeces for segments or eggs. In some cases the attention of the diagnostician is attracted to expelled segments by the dog's licking around the anus or his “sliding” on the anus. A mild laxative will generally result in the expulsion of a few segments, and this method of confirming suspicions is occasionally used.

Even if segments are not found in the excreta, it is a good plan to treat the dogs for tapeworms, so as to remove all doubts as to their presence. Dogs which come in contact with herds should certainly be treated occasionally to prevent any possibility of infecting the stock animals.

It will be noticed that the larval stages of three of these tapeworms are injurious to stock animals, namely, *T. marginata*, *T. coenurus*, and *T. echinococcus*.

The larvae of the others are of comparatively little economic impor-



FIG. 93.—Young cysticercus (*Cysticercus tenuicollis*) of the Marginate Tapeworm (*Taenia marginata*), natural size. (After Curtice, 1890, Pl. X, fig. 3a.)

tance, although it may be remarked that the larvae of *T. serrata* are sometimes fatal to rabbits, while the adult *D. caninum* sometimes occurs in children, who become infected with it by too intimate association with dogs. While playing with dogs they unconsciously get fleas upon themselves which they afterwards swallow. The fleas are digested and the larvae contained in their bodies, becoming free in the intestine, develop into tapeworms.

It is very difficult to distinguish between the adult forms of *T. coenurus* and *T. serialis*. The later is quite common in America.

If *T. echinococcus* is found to be present in a dog, the safest plan is to kill the dog and burn its carcass. The larval form of this parasite is so dangerous to man that it is not safe to have the dog around or to handle it, as is necessary in administering the treatment.

Taenia marginata develops in the dog, as stated elsewhere, in about ten to twelve weeks; *T. serrata* in about eight weeks; *T. coenurus* in two and a half to eight weeks.

The table following, giving the more common tapeworms in dogs, has been compiled from the various sources cited, and shows the comparative frequency of the various forms. There are as yet no extensive statistics for this country.

Number and percentage of dogs infected with tapeworms.

Locality.	Total number of dogs examined.	<i>Taenia marginata</i> .		<i>Taenia serrata</i> .		<i>Taenia concolor</i> .		<i>Taenia serialis</i> .		<i>Taenia echinococcus</i> .		<i>Dipylidium caninum</i> .		<i>Monostomum des kineatus</i> .		<i>Bothriocephalus</i> .		Authority.
		No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	
Washington and elsewhere ¹	()	Present.		Present.		0	0	Present.		Very rare.		Common.		0	0	0	0	Stiles & Hassall (unpublished).
Washington, D. C.	50	1	2	6	12	0	0	0	0	0	0	23	44	0	0	0	0	Sommer, 1896.
Lincoln, Nebr.	20	1	5	9	45	0	0	1	5	0	0	13	65	0	0	0	0	Ward, 1897, p. 172.
Iceland, 1863.	100	75	75			18	18			28	28	57	57	21	21	5	5	Krabbe, 1865, p. 21.
Copenhagen and vicinity, 1860-1863.	500	71	14.2	1	.2	5	1			2	.4	240	48			1	.2	Krabbe, 1865, p. 4.
Copenhagen.	()	()	17.3	()		()	2.16	()		()	1.08	()	47.03	()	()	()	()	Krabbe, ² 1867 or 1862?
Leipzig, Saxony.	()	()	27	()	15	()	1					()	25					Schöne, 1896.
Berlin, Prussia.	20	No record.		No record.		No record.		No record.		0	0	No record.		No record.		No record.		Naunyn, 1893, p. 415.
Berlin, Prussia, 1898.	200	14	7	10	5	1	.5			2	1	80	40			1	.5	Deffe, 1891.
Stettin.	12	No record.		No record.		No record.		No record.		3	25	No record.		No record.		No record.		Oft. after Ostertag, 1896, p. 424.
Zürich, Switzerland.	()	()	5	()	2.3	()	1.7			()	3.9	()	21					Zachokke.
Lyons and vicinity, France.	84	11	13	23	27.3	1	1.2			6	7.1	75	89.2	16	7.1			Bertholus & Chauveau, 1879, p. 309.
Melbourne, Australia, 1883.	10	4	40							5	50	6	60					J. D. Thomas, 1884, p. 192.
Adelaide, Australia.	20	18	90							9	45	118	90			1	5	J. D. Thomas, 1882, p. 436; 1884, p. 190.
Elsewhere in South Australia, 1882-83.	10	No record.								4	40	No record.						J. D. Thomas, 1884, p. 190.

¹ From time to time Hassall, Curtice, Stiles, and several volunteer assistants have examined dogs in this laboratory, but none of the examinations except those made by Sommer, were conducted with a view to establishing statistics, and hence no exact records have been kept. I have personally seen adults of *T. marginata*, *T. serrata*, *T. serialis*, *T. echinococcus*, and *D. caninum*, and larvae of the four species of taenias collected in various parts of the United States.

² After Deffe, 1891, p. 239; Krabbe's article not in Washington.

³ Recorded as "*T. thierms*" = *T. pseudo-cucumerina* = *M. lineatus*.

⁴ Also observed one case of *T. serialis* (see B & C., 1879, p. 297), but apparently not in this lot of dogs.

⁵ Thomas is not certain that these specific determinations were "invariably correct."

⁶ This is recorded from the first 13 dogs examined (see Thomas, 1882, p. 436); no mention is made of the *Bothriocephalus* in the other dogs.

*Treatment.*¹—The method of treatment is much the same as that followed in tapeworm disease of man; first prepare the patient by feeding him on a light diet of milk, soup, bread, etc., and then administer anthelmintics. It is important that the dog should be confined during the entire period of preparation and treatment.

In selecting a remedy, it is well to consider the following drugs. The

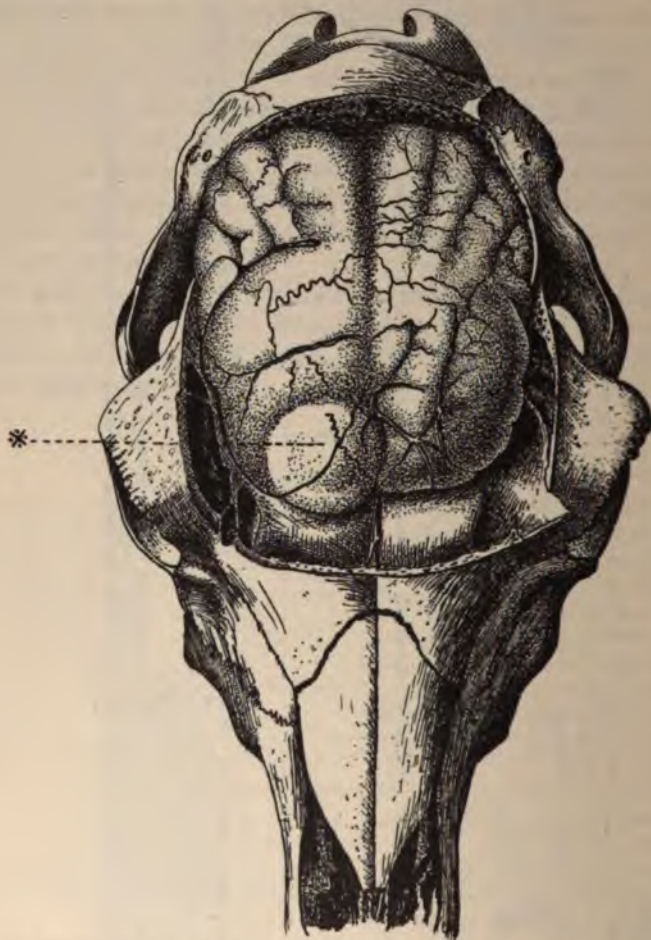


FIG. 94.—Skull of a sheep showing the brain infested with a Gid Bladder Worm* (*Coenurus cerebralis*), $\frac{1}{2}$ natural size. (After Railliet, 1893, p. 256, fig. 150.) See p. 108.

doses (apothecaries' weight) here given and the remarks on the drugs are abstracted from French (1896).

The doses of pelletierine tannate are, for adults, 5 to 15 grains; puppies, $\frac{1}{4}$ to 5 grains. Pelletierine is undoubtedly the most efficient and innocuous taeniocide for the dog we possess, but is not much used on account of its expense. French

¹ In this connection consult French, 1896, and Curtice, 1890, pp. 77-78.

has frequently found it most useful when the stomach has refused to retain other remedies. It should be administered in gelatin-capsular form in conjunction with powdered purgatives.

Aspidium is perhaps the most reliable of all the vermifuges, with the exception of pelletierine. For everyday practice it is to be preferred to all other remedies when given in the form of oleoresin. Doses: For adults, 15 to 40 minims; puppies, 5 to 15 minims. The dose of the liquid extract is the same.

Kamala is a very efficient taeniicide with drastic purgative properties. Given in small amount as an adjunct to other taeniocides, particularly to the oleoresin of male fern, it will be found a very valuable remedy. Doses: Adults, 15 to 30 grains; puppies, 3 to 15 grains.

Brayera (U. S. P.), *Cusso* (B. P.), yields kosin or koussin, to which it owes its taeniocidal properties. It is one of the best and safest taeniocides, its action being directly toxic to the worm, but it is too expensive for ordinary practice. The infusion (*Infusum brayerae*, U. S. P.) and fluid extract (*Extractum brayerae fluidum*) are both too bulky and disagreeable for administration to dogs. Kosin may be given in capsules in doses: Adults, 10 to 40 grains; puppies, 10 to 20 grains. The drug usually acts as its own cathartic, but it is better to employ some adjunct for this purpose.

Powdered *areca nut*, when freshly ground, is a very good remedy for tapeworm. When old, it will generally be found inert; consequently, it is best always to purchase the nut and grind or grate on an ordinary nutmeg grater. It is still largely used by British veterinarians and is a favorite with some Americans, but it can not be regarded as being either as effectual or easy of administration as the two preceding drugs. Its effects on puppies are not unattended with danger, on account of its great astringency; but with due regard to subsequent purgation it is a perfectly safe remedy. Mayhew's method of prescribing 1 to 2 grains to every pound weight of the dog is usually followed, but the smaller quantity will generally suffice, provided the powder is freshly ground. It may be conveniently given in gelatin capsules, accompanied or followed by a purgative.

Turpentine is a powerful remedy against tapeworms, but it is regarded as being somewhat dangerous from its liability to produce strangury and renal inflammation. These effects are said to be less pronounced after large than after small doses; but large doses are more liable to cause gastric and enteric inflammations. It can hardly, therefore, rank with the best remedies. Administer in emulsion with white of an egg, mucilage, milk or oil. Doses: Adults, 10 to 15 minims; puppies, 3 to 10 minims.

Dr. Hoskins has had very satisfactory results with this drug in puppies under 6 months of age and has never noticed any gastric or renal results. In very young puppies he rarely gives over 2 minims, carrying it up to 10 minims, and repeating for two or three days on an empty stomach in the morning, allowing no food for an hour or two after its administration.

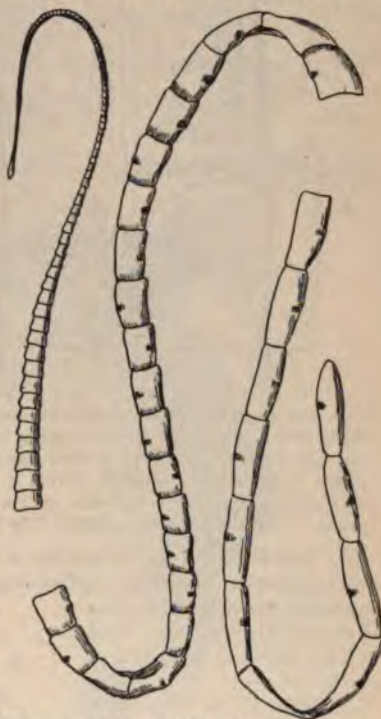


FIG. 95.—An adult Gid Tapeworm (*Taenia coenurus*), natural size. (After Railliet, 1896, p. 244, fig. 135; see also figs. 86c and 88c.) See p. 108.

The following suggestions as to doses, compiled from various sources, are taken from Curtice (1890):

- (1) Allow 2 grains of freshly powdered areca nut for each pound of the dog's

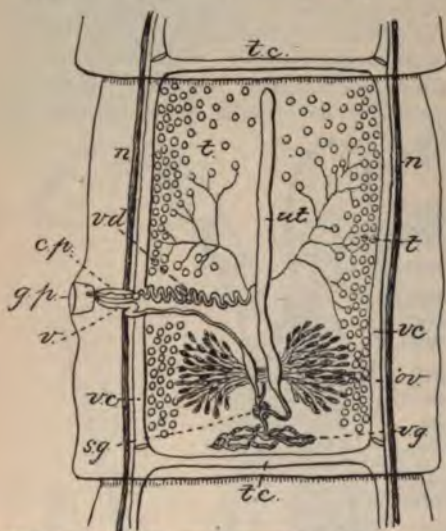


FIG. 96.—Sexually mature segment of the Gid Tapeworm (*Taenia coenurus*): *cp*, cirrus pouch; *gp*, genital pore; *n*, nerve; *ov*, ovary; *sg*, shell gland; *t*, testicles; *tc*, transverse canal; *ut*, uterus; *v*, vagina; *vc*, ventral canal; *vd*, vas deferens; *vg*, vitellogene gland. $\times 20$. (After Deffke, 1891, Pl. I, fig. 3.)

- (2) One teaspoonful of turpentine and two tablespoonsful of castor oil given in a cup of milk; the final dose of physic is not given in this case.
- (3) Twenty drops of oil of male shield fern, 30 drops of turpentine, and 60 drops of ether. Beat together with one egg and give to the dog in soup.
- (4) Hagen advises 80 grains of oxide of copper with 40 grains each of powdered chalk and Armenian bolus; mix with sufficient water to make an adherent mass, and divide into 100 pills. Administer one pill three times daily for ten days in meat or butter.
- (5) Röhl prescribes the following dose for large dogs; smaller doses should be given in proportion to the size of the dog:
- (a) Two drachms each of extract of male fern and of powdered male fern; or—
- (b) Decoction of $2\frac{1}{2}$ ounces of pomegranate-root bark in water, reduced to 6 fluid ounces, to which add 1 drachm of extract of male fern. Give in two doses, at intervals of one hour; or—
- (c) One-half to 1 ounce of kousso, made into pills, with honey or molasses and a little meal; or—
- (d) From $1\frac{1}{2}$ to $2\frac{1}{2}$ drachms of kamala, stirred with honey or water, and given in two doses inside of an hour.

[a, b, and c, should be followed in two hours, with castor oil, but this is not necessary for d.]

After treatment, all the faeces passed during the confinement of the patient should be collected and burned or buried in quicklime.

22. The Gid Bladder Worm (*Coenurus cerebralis*) of Sheep and Calves, and its adult stage, The Gid Tapeworm (*Taenia coenurus*) of Dogs.

[Figs. 87 C, 89 C, 94–100.]

The Gid Bladder Worm is an important and dangerous parasite to the sheep industry, but fortunately it does not seem to be prevalent in this country.



FIG. 97.—Brain of a lamb infested with young Gid Bladder worms (*Coenurus cerebralis*), natural size. (After Leuckart, 1880, p. 456, fig. 206.)

LARVAL STAGE (*Coenurus cerebralis*).

For anatomical characters, compare figs. 97, 99, 100 with key, p. 21.

SYNONYMY.—*Fermis vesicularis socialis* Bloch, 1782; *Taenia vesicularis* Goeze, 1782; *Multiceps* Goeze, 1782; *Hydatigena cerebralis* Batsch, 1786; *Vesicaria socialis* Schrank, (1788); *Taenia cerebralis* (Batsch) Gmelin, 1790; *Polycephalus ovinus* Zeder, 1803; *P. bovinus* Zeder, 1803; *Coenurus cerebralis* (Batsch) Rudolphi, 1808.

HOSTS.—Calves, sheep, mutton, goat, roedeer, reindeer, dromedary, horse. (See pp. 137-143.)

ADULT STAGE (*Taenia coenurus* Küchenmeister, 1853).

For anatomical characters, compare figs. 95 and 96 with key, p. 101.

BIBLIOGRAPHY.—For technical discussion, see especially Deffke (1891).

HOSTS.—Dogs and wolves. (See pp. 137-143.)

Life history.—Starting with the adult worm (fig. 95) in the intestine

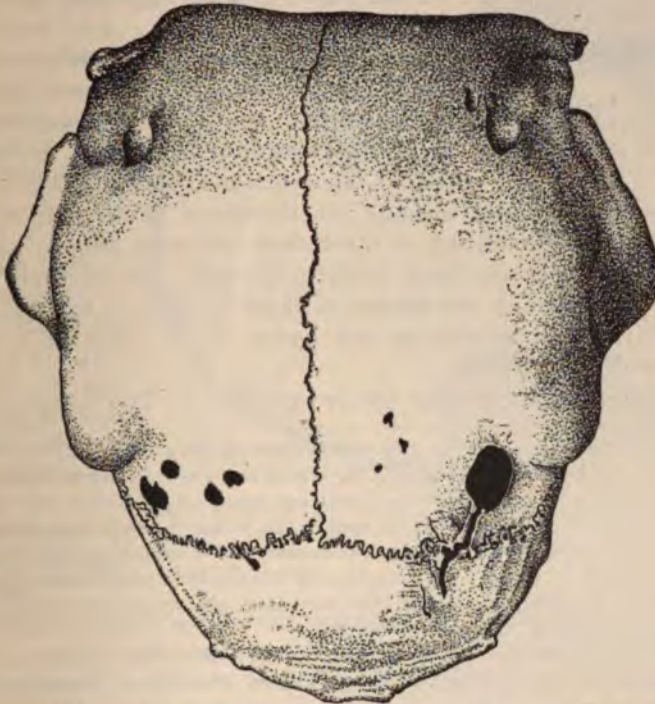


FIG. 98.—Sheep's skull, the hind portion thin and perforated, due to the presence of Gid Bladder worms (*Coenurus cerebralis*). (After Dewitz, 1892, p. 65, fig. 47.)

of the dog, the eggs are scattered on the ground, living three to four weeks in a moist place, and are taken in by the sheep or cattle along with the fodder or water. On becoming free in the intestine, the embryo bores through the intestinal wall and reaches the brain or spinal cord, probably aided in its wanderings by the blood current. Arriving in the brain, the young worm loses its hooks and develops into a cyst (fig. 97), which preserves for some time the power of locomotion and bur-

rows small galleries or canals in the nervous tissue, the canal gradually growing larger as the parasite increases in size. In fourteen to nineteen days after infection, small (0.5 to 1.5 mm.) cysts are found in the brain substance, and similar structures are sometimes found in the muscles, especially of older animals. Those in the muscles generally atrophy in a short time, but those in the brain¹ continue to grow, in twenty-five to forty-five days, causing the symptoms of "gid" or "staggers;" in fifty days they reach the size of a hazelnut and show the anlagen (primordii) of the scolices; in two to three months they complete their development. The heads (figs. 99, 100) form in invaginations, generally at one end of the cyst, the invaginations growing in a bunch. If these heads are fed to dogs they develop into adult tapeworms, which produce eggs after about² four to eight weeks.

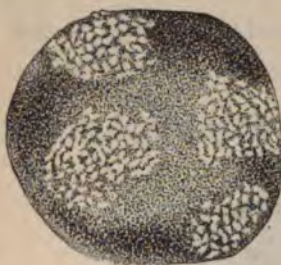


FIG. 99.—An isolated Gid Bladder Worm (*Coenurus cerebralis*), showing the heads. (After Railliet, 1886, p. 245, fig. 137.)

The disease in calves and lambs.—As intimated above, lambs are much more subject to the "gid" than are older animals, a fact which according to some authors finds its explanation in the circumstance that the embryos

can not force their way through the tissues of adults, but owing to the more pliable condition of the tissues of young animals they are able to penetrate to the brain without difficulty. In the case of cattle, however, although the disease is more frequent in animals a year or so old, it is not so rare to find 4-year old or 6-year old cows also infested with the parasite.

Three stages of the disease are recognized: (1) The period of infec-

¹ While generally found in the nervous centers (brain, more rarely in the spinal cord), it has also been reported once in the connective tissue of sheep (Eichler), once under the skin of a calf (Nathusius), and one extremely doubtful case has been reported to us from Minnesota of its occurrence under the skin of a horse. This latter case has not been examined by the Bureau, but I would suggest that *Taenia serialis* is common in America, and considering the tissue in which this parasite was found, it is not at all improbable that the Minnesota case was one of *Coenurus serialis* (*Taenia serialis*) rather than *C. cerebralis*.

² Statements are found in the writings of various authors that *T. coenurus* becomes "ripe," "mature," or "developed" in the dog in "ten days," "three to four" or "six to eight weeks." The expressions "ripe, matured, and developed" are, however, indefinite terms, for in some writings they refer to the stage in which the genital glands are active, in other writings they refer to the gravid segments. Properly speaking, a segment is *mature* when its sexual glands are active; it is *gravid* or *ovigerous* when it contains embryos. Von Siebold found *gravid* segments thirty-eight days after infection; the strobilae were 16 to 26 inches long, and some segments had already been shed, showing that gravid segments were formed in less than thirty-eight days. Railliet states that according to Leuckart the distal segments "arrive at maturity" (probably meaning "gravid" in this case) after three to four weeks. According to Krender the worms develop in dogs "to fully-developed sexually mature tapeworms" in ten days (Zürn).

tion and migration; (2) a period of apparent though not real recovery, and, (3) the climax.

As gid is apparently not prevalent in this country, it is hardly necessary to give a detailed discussion of the symptoms and pathology. The following short account will suffice for the present:

If the parasites are located in the brain, we find the condition known as *cephalic gid*, if in the spinal cord we find *medullary gid*, also known as *lumbar gid* or *hydatid paraplegia*.

In *cephalic gid* there is at first indifference and weakness, an abnormal attitude of the head, which is of an unusually high temperature, and vascular injection of the sclerotica; pressure on the skull causes pain; the most characteristic symptom of the disease is the action of the animal in turning in circles to the right or left, the circles becoming smaller until the patient pivots around on one spot; in some cases it acts as if intoxicated, often stumbles and falls; the eyes are turned in or out, and grinding of the teeth is noticed. The exact position of the parasite determines the particular symptoms.

In *medullary gid* there is a gradual paralysis of the hind legs, paralysis of the rectum and bladder, paleness of the mucous membranes, shedding of the wool, etc.

Cephalic gid should not be mistaken for *vertigo* due to heat, *epilepsy*, *blindness*, or *false gid* due to grubs in the head. *Medullary gid* should not be confounded with the *trembling disease* (the Scotch *louping-ill*) or *lumbar prurigo*.

Treatment.—There is no medical treatment which can be suggested; surgical treatment is sometimes resorted to, but should be performed only by a veterinarian since it is necessary to locate the parasite before operating, and this can be done only by men of experience.

Prevention, however, can and should be practiced by every farmer. Dogs should be kept free from tapeworms. As *Taenia coenurus* develops in the dog in three to eight weeks, the treatment may be repeated two to five weeks after the first dose.



FIG. 100.—Diagrammatic section of a Gid Bladder Worm (*Coenurus cerebralis*): a, normal disposition of scolex; b, c, d, e, diagrammatic drawing to show the homology between cysticercus and coenurus. (After Railliet, 1886, p. 243, fig. 134.)

When gid is suspected in a flock of sheep or in cattle, one of the animals should be slaughtered and its skull examined for the parasite. If it is positive that gid is present, it is well to slaughter the affected sheep before the third stage of the disease sets in, as in the third stage they sometimes become very thin. The skulls of "giddy" sheep should not be fed to dogs unless they be first subjected to a long boiling, for if this precaution is not taken the infection will be spread.

The eggs retain their vitality less than twenty-four hours when exposed to an August sun (Leuckart); if kept moist they are alive after three weeks (Gerlach), but after eight weeks are unable to develop further (Leuckart).

It has been impossible for the writer to find any positive evidence of the existence of the Gid Bladder Worm in this country, yet in view of the importations from Europe of sheep and dogs, it is difficult to believe

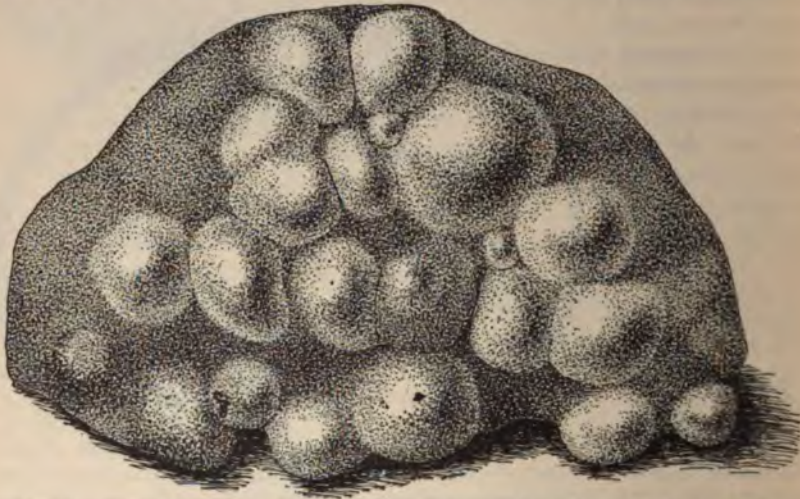


FIG. 101.—Portion of hog's liver infested with *Echinococcus hydatid*, natural size (original).

that we are entirely free from this parasite. Leidy, in 1856, makes a reference to a parasite "*Coenurus cerebralis* Rud.; in the sheep, *Capra aries*," which he evidently examined, but he gives no details as to where or when the parasite was found. One doubtful case of the presence of adult worm in dogs was recently recorded by Ward, of Nebraska, but I have examined the head of the worm and find it to be a *T. serialis*, see page 101.

ABATTOIR INSPECTION.

So far as infection of man is concerned, the abattoir inspection for *Coenurus cerebralis* is of no importance, for no case of *Taenia coenurus* has ever been recorded in the human species. If the parasite is found in abattoir inspection, care should be taken to dispose of it in such a way (heat) as to render an infection of dogs impossible.

The adult tapeworm in dogs.—Symptoms, etc., see page 101.

23. The *Echinococcus Hydatid* (*Echinococcus polymorphus*) of Man, Cattle, Sheep, Swine, etc., and its adult stage, The *Echinococcus Tapeworm* (*Taenia echinococcus*) of Dogs.

[Figs. 101-109.]

A third tapeworm of the dog, the larval form of which develops in cattle, sheep, and swine, is *Taenia echinococcus*. Since this parasite develops its larval stage in man also, and further, since it is the most dangerous animal parasite found in man, it is important to thoroughly understand its life history in order to guard against infection, although it is at present not very common in America.

LARVAL STAGE (*Echinococcus polymorphus*).

For anatomical characters, compare figs. 101, 105, 106-109 with key, p. 21.

SYNONYMY.—*Taenia visceralis socialis granulosa* Goeze, 1782; *Hydatigena granulosa* Batsch, 1786; *Vesicaria granulosa* (Batsch) Schrank, (1788); *Taenia granulosa* (Batsch) Gmelin, 1790; *Polycephalus hominis* Zeder, 1800; *Echinococcus* Rudolphi, 1802; *Polycephalus humanus* Zeder, 1803; *P. granulosa* (Batsch) Zeder, 1803; *P. echinococcus* Zeder, 1803; *Acephalocystis* Laennec, 1804; *Echinococcus granulosa* (Batsch) Rudolphi, 1805; *Hydatid erraticus* Blumenbach, 1805; *Acephalocystis humana* Lüdersen, (1808); *A. suilla* Lüdersen, (1808); *Echinococcus hominis* (Zeder) Rudolphi, 1810; *E. simiae* Rudolphi, 1810; *E. veterinorum* Rudolphi, 1810; *Polycephalus granulosus* Laennec, 1812; *Acephalocystis ovoidea* Laennec, 1812; *A. cystifera* Laennec, 1812; *A. granosa* Laennec, 1812; *A. surculigera* Laennec, 1812; *A. intersecta* Laennec, 1812; *A. ansa*¹ Laennec, 1812; *Echinococcus infusorium* F. S. Leuckart, (1827); *Acephalocystis eremita sterilis* Cruvielhiehl, (-?-); *A. prolifera socialis* Cruvielhiehl, (-?-); *A. endogena* Kuhn, (1830); *A. exogena* Kuhn, (1830); *A. granulosa* Chiaje, 1833; *A. communis* Chiaje, 1833; *A. prolifera* Chiaje, 1833; *A. simplex* Goodsir, 1844; (??) *Diskostoma acephalocystis* Goodsir, 1844; (??) *Astoma acephalocystis* Goodsir, 1844; *Echinococcus arietis* E. Blanchard, 1848; *E. giraffae* Gervais, (-?-); *E. polymorphus* Diesing, 1850; *E. pardi* Huxley, (1852); *E. scolicipariens* Küchenmeister, 1855; *E. coenuroides* Küchenmeister, 1855; *E. altripariens* Küchenmeister, 1855; (?) *Acephalocystis macaci* Cobbold, 1861; (?) *A. vis tragelaphi* Cobbold, 1861; *Cysticercus echinococcus* (Zeder) Koeberlé, 1861; *Echinococcus cerebri* Spiering, 1862; *E. hepatis seu process. vermiformis* Scholler, 1862; *E. hydatidosus* R. Leuckart, 1863; *E. endogena* (Kuhn, 1830) Leuckart, 1863; *E. multilocularis* Leuckart, 1863; *E. lienis* Kehlberg, 1873; *E. pulmonum* Huppert, 1875; *E. multilocularis hepatis* Haffter, 1875; *E. intercranialis* Fricke, 1880; *E. simplex* Leuckart, 1880; *E. racemosus* Leuckart, 1880; *E. multiplex* Stiller, 1882; *E. alveolaris* R. Blanchard, 1886; *E. retroperitonealis* Bitter, 1886; *E. mesenterii* Surmann, 1891; *E. cerebri* Perroncito, (18—); *E. cysticus* Huber, 1891; *E. unilocularis* Huber, 1896; *E. multilocularis exulcerans* Huber, 1896; *E. osteoklastes* Huber, (?) 1896; *E. subphrenicus* Huber, 1896; "*Echinokokkus*" (!) of Schneidemühl, 1896.

BIBLIOGRAPHY.—For detailed technical discussion of the parasite, see especially Leuckart (1880, I, pp. 732-825); for discussion of hydatid disease in man, see especially Neisser (1877); J. D. Thomas (1884); Davaine (1877, pp. 356-666); for bibliography, see especially (prior to 1864) Diesing (1850, pp. 842-844, and 1864, pp. 395-397); (1861-1880)

¹*A. plana* Laennec, 1812, a seventh supposed but doubtful variety described by Laennec, has since been determined as a spurious parasite, representing albuminous concretions occasionally found in the wrist, and afterwards described by Dupuytren as *Ovuligera carpi*. *A. racemosa* Cloquet, an eighth supposed variety, is another spurious parasite later determined as chorial vesicles.

Taschenberg (1889, pp. 1036-1057); (1877-1890) Huber (1891, pp. 5-39); also Billings, Index Cat. Lib. Surg. Gens. Office, United States Army, 1885, VI, pp. 530-535.

Hosts.—Man, cattle, sheep, swine, and other animals. (See pp. 137-143.)

ADULT STAGE (*Taenia echinococcus* Siebold, 1853).

For anatomical characters, compare figs. 102-104 with key, p. 101.

SYNONYMY.—“*Taenia cateniformis*” misdet. pro parte Rudolphi, 1808; “*T. cucurbitina* Bloch” misdet. pro parte, Diesing, 1850; “*T. serrata*” misdet. Röll, 1852; *T. echinococcus* Siebold, (1853); *T. nana* Beneden, 1858 [nec Siebold, 1852]; *Echinococcifer echinococcus* (Siebold) Weinland, 1858; “*T. echinococca*” of Koeberlé, 1861; *T. (Echinococcifer) echinococcus* of Leuckart, 1863; *T. (Arhynchotaenia) echinococcus* of Diesing, 1864; *T. (Echinococcus) echinococcus* of Railliet, 1886; *T. “echinokokkus”* of Schneidmühl, 1896.

Hosts.—Dog, dingo, jackal, wolf, cougar (?). (See pp. 137-143.)

Life history.—Starting with the adult tapeworm (fig. 103) in the small intestine of the dog or wolf, the eggs are scattered over the ground and are swallowed by the intermediate host with the fodder or



FIG. 102.—Portion of the intestine of a dog infested with the adult Hydatid Tapeworm (*Taenia echinococcus*), natural size. (After Ostertag, 1895, p. 430, fig. 99.)

water. Upon arriving in the stomach, the eggshells are destroyed and the six-hooked embryo, which is thus freed, bores its way through the intestinal wall and wanders, actively or passively (that is, carried along by the blood), to various organs of the body, liver, lungs, ovaries, bones, skull, etc., where it develops first into an *acephalocyst*, which may develop further into any of the variations given below in the description of the larval stage.

The heads which are formed, upon being devoured by a dog or wolf, then develop into adult tapeworms.

The larval stage develops rather slowly, and may persist for many years. Thus, cases are on record where the hydatid has existed for 2, 4, 8, 15, 18, and even 30 years in man, very often, however, with fatal results.

Modifications of the hydatid cysts.—The larval stage appears in several different forms, which have been described under various names as representing different species. It is now admitted, however, by nearly all authors, especially by zoologists, that all these forms belong to one species and have been brought about by different modes of growth. Let us assume that a six-hooked embryo has reached the liver, lungs, or some other organ of the secondary host (man, cattle, sheep, etc.).

About four weeks after the infection small cysts, scarcely 1 mm. in diameter, are noticed in the interlobular tissue of the liver, for instance. They consist of an outer cyst, formed by the connective tissue of the host, and an inner solid body, 0.25 to 0.50 mm. in diameter, which represents the young parasite. The six hooks of the embryo have been discarded and the organism consists of an outer transparent capsule—the cuticle—20 to 50 μ in thickness, and a granular content somewhat condensed on the periphery and containing cells which are not distinctly separated from one another. At the end of eight weeks the parasite has doubled in size. The cuticle, which is very elastic, grows thicker and its inner surface is covered

by a thin membrane (endocyst, parenchym layer, germinal layer) which represents the condensed granular content; this was at first solid and occupied the entire space inside the cuticle. The endocyst now incloses a cavity containing a clear watery fluid. The parasite continues to grow, the cuticle becomes stratified; the germinal layer shows a histological differentiation into small cells occupying the periphery, large cells on the inside, and granular cells occupying the irregular spaces on the surface. At the end of nineteen weeks the parasite has reached 10 to 12 mm. in diameter; the liquid in the interior contains a number of chemical compositions, the parenchym layer has grown slightly, the cuticle is about 0.2 mm. thick. When the parasite is composed of only these portions, that is, *cuticle*, *endocyst*, and the contained *liquid*, it represents the form which some authors include under the term *Acephalocystis*. If we imagine all the portions of fig. 105 absent, which are designated by the letters *a* to *z*, the portions *cu* and *pa* being left, we have before us a simple *acephalocyst* (headless echinococcus hydatid). Although the parasite frequently remains in this condition, or rather is found in this condition, the acephalocyst does not represent the final larval stage. Referring to fig. 105, *a*, we see a slight proliferation of the parenchyma. This protuberance grows gradually into the cavity of the hydatid and develops into a brood capsule, *b, c*, the cavity of which is lined by a thin cuticle. The heads of the succeeding generation of tapeworms develop in these brood capsules, but authors are not entirely agreed as to how they develop. Thus, Leuckart states that a diverticulum is formed which extends into the cavity of the hydatid cyst, that the head is formed at its base, and the diverticulum then invaginates. The successive stages may be seen in *c, d*, and *e* of fig. 105. Moniez, on the other hand, states that the head develops inside of the brood capsules, passing through the stages *f, g, h*, and *i*; he admits, however, that there is occasionally a diverticulum formed, at the end of which is developed a head, not in the manner described by Leuckart, but in the same manner as if the head had formed inside the brood capsule *f, k*. Whatever may be the mode by which these heads are formed, several (5, 10, 20, or even 34) may develop in one brood capsule. As numerous brood capsules may develop in one hydatid cyst, it is not to be wondered at that many thousand heads are sometimes found in hydatid cysts. Occasionally the brood capsules will be found ruptured, so that the heads extend free into the cavity of the hydatid (*m*), and heads are occasionally found floating free in the liquid of the cyst (*n*). The hydatid, so far as we have traced it (with *cu, pa, a-n*), is a mature larval stage such as is frequently found in animals, and if this cyst is devoured by a dog the separate heads or scolices will develop into adult tapeworms.



FIG. 104.—Hooks of adult Hydatid Tapeworm: *a*, from a hydatid; *b*, three weeks after feeding to a dog; *c*, from an adult; *d*, combined figures of *a-c*, showing the gradual changes in form. $\times 600$. (After Leuckart, 1880, p. 736, fig. 315.)



FIG. 103.—Adult Hydatid Tapeworm (*Taenia echinococcus*), enlarged. (After Leuckart, 1880, p. 743, fig. 316.)

the head is formed at its base, and the diverticulum then invaginates. The successive stages may be seen in *c, d*, and *e* of fig. 105. Moniez, on the other hand, states that the head develops inside of the brood capsules, passing through the stages *f, g, h*, and *i*; he admits, however, that there is occasionally a diverticulum formed, at the end of which is developed a head, not in the manner described by Leuckart, but in the same manner as if the head had formed inside the brood capsule *f, k*. Whatever may be the mode by which these heads are formed, several (5, 10, 20, or even 34) may develop in one brood capsule. As numerous brood capsules may develop in one hydatid cyst, it is not to be wondered at that many thousand heads are sometimes found in hydatid cysts. Occasionally the brood capsules will be found ruptured, so that the heads extend free into the cavity of the hydatid (*m*), and heads are occasionally found floating free in the liquid of the cyst (*n*). The hydatid, so far as we have traced it (with *cu, pa, a-n*), is

a mature larval stage such as is frequently found in animals, and if this cyst is devoured by a dog the separate heads or scolices will develop into adult tapeworms.

From this point, or even before it, several modes of development are open for the

hydatid: Thus, small centers of growth (*o, p, q, u*) may form in the wall of the parasite. As these growths increase in size a cuticle is formed around them (*p, q*), and they burst through the wall in which they are growing and continue their further development in the same manner as the mother hydatid. If these so-called *daughter cysts* fall into the cavity of the mother cyst, the entire parasitic cyst (mother hydatid + daughter hydatids *v, x*) presents to us the form described as the *endogenous Echinococcus* (*Acephalocystis endogena* Kuhn, *Echinococcus altricipariens* Küchenmeister, and *E. hydatidosus* Leuckart), found particularly in man, hogs, and

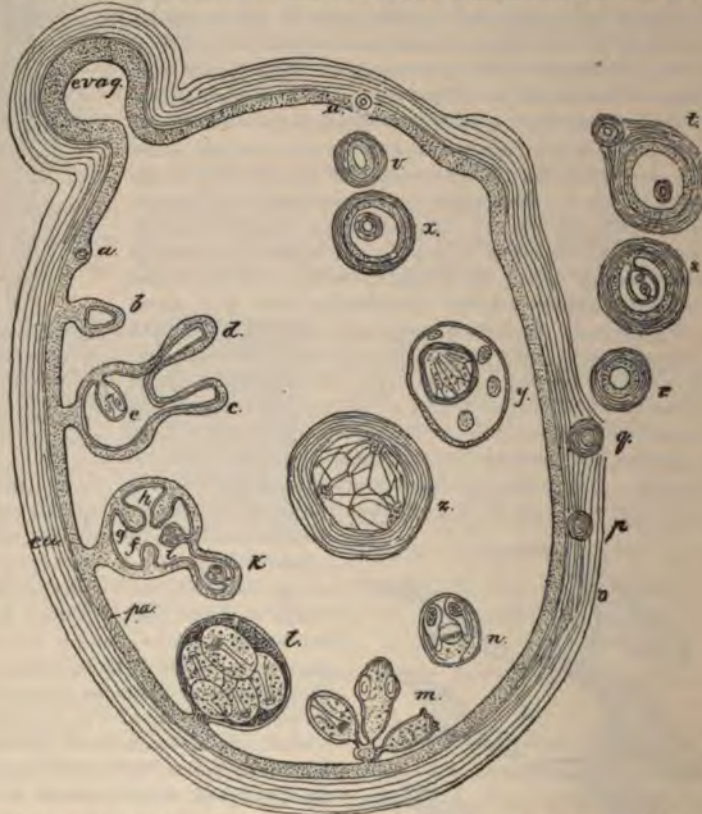


FIG. 105.—Diagram of an *Echinococcus* hydatid: *cu*, thick external cuticle; *pa*, parenchym (germinal) layer; *c, d, e*, development of the heads, according to Leuckart; *f, g, h, i, k*, development of the heads according to Moniez; *l*, fully developed brood capsule with heads; *m*, the brood capsule has ruptured, and the heads hang into the lumen of the hydatid; *n*, liberated head floating in the hydatid; *o, p, q, r, s*, mode of formation of secondary exogenous daughter cyst; *t*, daughter cyst with one endogenous and one exogenous granddaughter cyst; *u, v, x*, formation of endogenous cyst, after Kuhn and Davaine; *y, z*, formation of endogenous daughter cysts, after Nannyn and Leuckart; *y*, at the expense of a head; *z*, from a brood capsule; *evag.*, constricted portion of the mother cyst. (After R. Blanchard, 1886, p. 426, fig. 257, slightly modified.)

horses. The growth does not necessarily stop with the daughter cysts, but a third generation of cysts (*granddaughter cysts*) may form in the same manner inside of the daughter cysts, as shown in *x*. The brood capsules of the mother cyst, or even the separate scoleces, may, according to certain authors, fall into the cavity and develop into daughter cysts. If the daughter cysts continue their growth outside of the mother cyst, as shown in *q, r, s, t*, we have the form described as the *exogenous Echinococcus* (*Acephalocystis exogena* Kuhn, *Echinococcus scolicipariens* Küchenmeister, *E. simplex*, and *E. granulatus* Leuckart). It will be at once seen that it is sometimes difficult to decide whether the parasite is an exogenous echinococcus or whether the cysts *s* and *t* have developed from six-hooked embryos.

In the case of *endogenous echinococcus* it would not be at all strange if we found the scolices free in the liquid *n* or a ruptured brood capsule *m*, caused by contact of the brood capsule with the daughter hydatids.

Generally, the hydatids are more or less round, but frequently diverticula (*evag.*) are noticed in the walls; for the cyst will naturally develop in the direction of the least pressure, and if this pressure is least at one particular portion of the cyst a diverticulum will naturally form at that point. This growth of diverticula leads us to the consideration of the form of hydatid known as *Echinococcus racemosus* and still another form not distinctly separated from *E. racemosus*, that is, *E. multilocularis* (*E. alveolaris*, the "tumeur hydatique alveolaire" of Carrière).

E. racemosus Leuckart, the grape Echinococcus (fig. 106), is composed of a number of cysts more or less intimately connected with each other, so as to give the appearance of a bunch of grapes or of fish spawn. It is difficult to distinguish in some cases whether the parasitic growth represents a heavy infection of small hydatids, each of which has grown from a six-hooked embryo, or whether all the cysts have arisen by budding from a single cyst. Cases of this kind have been reported in cattle by Kuhn and others.

E. multilocularis,¹ as stated, is a form of growth which is not distinctly separated from *E. racemosus*; in fact, the two may easily be classed together, as Leuckart suggests. *E. multilocularis* s. st. represents a group of small hydatids (figs. 107-109) lying close together, in many cases connected in a common stroma. This variety is found chiefly in Switzerland and Germany, where about 70 cases have been reported in the liver of man and a number of cases in cattle.

If a section is made of the parasitic growth we find numerous small caverns of irregular shape, containing a rather transparent gelatinous substance and embedded in a common substance or stroma of connective tissue, in which blood vessels and gall ducts are occasionally seen. The liver cells, however, are entirely atrophied. For many years the nature of these parasitic growths was misunderstood and they were diagnosed as colloid cancers until Virchow (1856) discovered that they were hydatids.

Four other terms which have been applied to the hydatids also need a word of explanation. Rudolphi made use of the terms *E. hominis*, *E. simiae*, and *E. veterinorum* to designate the echinococcus of man, apes, and other animals, respectively, supposing that they belonged to three separate species.

Diesing, however, maintained that all three forms represent the larval stage of one species and introduced the name *E. polymorphus* to designate the larval parasite, a name which zoologists now quite generally accept.



FIG. 107.—Section through a multilocular Echinococcus. $\times 30$. (After Leuckart, 1880, p. 796, fig. 335.)



FIG. 106.—A racemose Echinococcus, natural size. (After Leuckart, 1880, p. 795, fig. 334.)

HYDATID DISEASE IN VARIOUS ANIMALS.

The disease caused by the larval stage of this parasite is known as Hydatid, or Echinococcus, disease. In general terms, the hydatid may occur in any organ of the body, but is most commonly met with in the liver or lungs. The symptoms will of course vary according to the location of the parasite.

¹Several authors, more particularly Müller and Mangold, consider that this form represents a distinct species. The ordinary adult is said to have plumper hooks, while the eggs are not collected in "egg balls." The adult of *E. multilocularis* is said to have more slender hooks and its eggs are described as collected in "egg balls."

It is not at all rare that the hydatids are not known to be present until discovered by post-mortem examination; they may however become very dangerous because of their situation, their volume, and

the pressure they exert. When they occupy an important organ, when they reach a large size, and when the walls of the cysts become osseous or cartilaginous; or when numerous, they may cause serious trouble or death; they are frequently fatal when after bursting they are discharged through an organ communicating with the exterior, symptoms persisting and increasing, the expelled matter having a gangrenous odor, or when they discharge into a serous cavity or into a large blood vessel.



FIG. 108.—A multilocular *Echinococcus* from the liver of a steer, natural size. (After Ostertag, 1895, p. 427, fig. 94.)

Hydatid disease in cattle.—Three cases are known where cows died suddenly which had hydatids in the heart; Fuisen is authority for the statement that the hydatids of cattle are short lived, and show a great tendency to degenerate and become calcified. (See also under "Abattoir inspection," p. 121.)

Symptoms.—The parasites are generally found in the liver and lungs, seldom in the heart. When in the heart symptoms are not generally exhibited unless the cyst breaks through the muscular wall and hangs into the cavities of the heart, or when the cyst discharges; in these cases apoplexy is generally the result. It is scarcely possible to diagnose echinococcus of the spleen. In echinococcus of the lungs a slight cough is first noticed, which increases according to the degree of infection and the size of the parasites, occurring at times every five or ten minutes. This cough is absent when the liver instead of the lungs is particularly infected. Respiration increases to 80 or 84 per minute. Inspiration is broken. Fever is at first absent; pulse about 70 to 85; milk secretion is lessened, appetite normal except toward the end of the disease, when the hide becomes bound, hair becomes stiff and dry. Pressure on the right side of the region of the four last ribs causes the animals to show signs of pain, and there is a dull per-

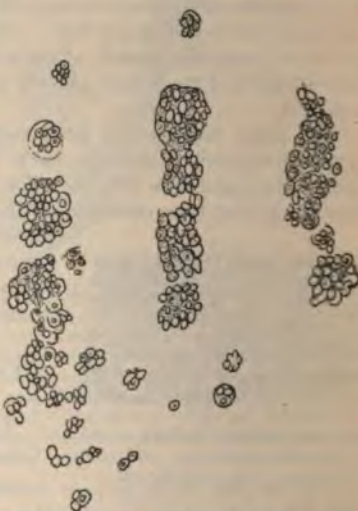


FIG. 109.—A multilocular *Echinococcus* from the pleura of a hog, natural size. (After Ostertag, 1895, p. 428, fig. 97.)

cussion sound similar to, though not so deep as that in pleuro-pneumonia, covering small areas or the entire breast and the region of the right lobe of the liver. Placing the ear on the chest one hears a heavy harsh breathing mixed with other sounds, whistling, rattling, or at the moment of inspiration, an exceedingly characteristic tone which Harms has named "Guurksen" (cloc-cloc of Hartenstein), and which one hears when he presses and shakes bladders filled with liquid. In liver echinococcus the labored breathing is generally absent, but digestive troubles are present, appetite and rumination become irregular; intestinal catarrh, indigestion; a yellowish color of the eyes are noticed. (Abstracts from Zürn (1882, p. 136) and others; Harm's *Die Echinococcus-Krankheit des Rindes*, 1870, is not accessible here.)

A rectal exploration occasionally shows an enormously enlarged liver, and thus directs suspicion to the disease.

In ante-mortem examinations hydatid disease of the lungs in cattle

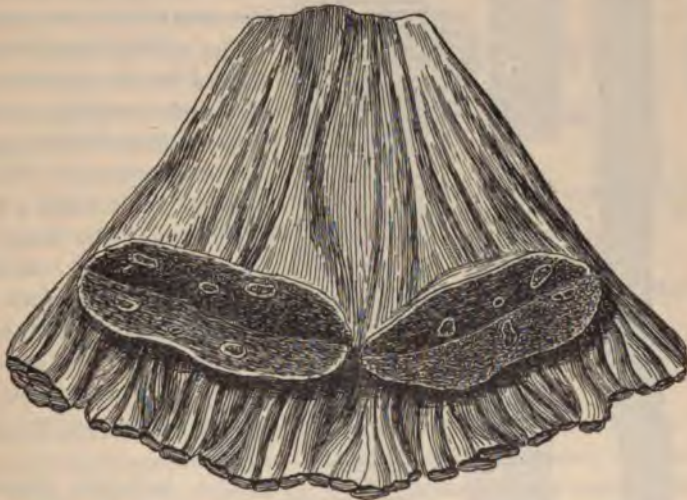


FIG. 110.—Lymphatics of a steer infested with the so-called "Tongue worm" (*Linguatula rhinaria*). (After Ostertag, 1895, p. 434, fig. 102.)

may be mistaken for pleuro-pneumonia, but in the latter disease the sounds upon percussion are deeper and duller than in the former disease. It will be recalled that contagious pleuro-pneumonia is not found in the United States.

For differential diagnosis in post-mortem examinations, see page 121.

Hydatid disease in sheep.—Very little is written upon this subject, but from the data published the symptoms shown by sheep are as vague and indefinite as those exhibited by cattle.

Feebleness, dullness, and indifference, though these may not be very marked, except at the last stages of the malady, when the animal is cachectic. There are frequent tympanites, and pruritus at various points; the wool is dry and brittle and easily pulled out, and, in general, the symptoms are confounded with those of *fascioliasis* (*distomatosis*). (Neumann.)

Hydatid disease in swine.—No particular symptoms have been described for hydatid disease in swine.

Pathology.—The pathological lesions naturally vary according to the organs in which the parasites are situated. There may be an enormous increase in the size and weight of the lungs or liver. The normal weight of the liver of an ox is about 5 kilograms (11 pounds), but hydatid livers have been recorded which weighed 50 kilograms (110

pounds), 130 pounds, 145 to 146 pounds, and even 158 pounds. A pig's liver weighs on an average about 2 kilograms (4.4 pounds) when normal, but hydatid livers have been recorded weighing 50 to 100 pounds. A steer's lungs, normal weight 6 pounds, may increase to 40 or 54 pounds.

The increase in size of these organs by the growth of the parasites naturally causes a displacement of other organs; the curvature of the diaphragm is changed; the intestines may be compressed and constricted; adhesions may form; the surface of the organs containing the parasites naturally assumes an abnormal outline, bulging out at points corresponding to the hydatids.

The hydatids themselves cause an atrophy of the specific tissue of the organ, the connective tissue of which proliferates and forms a capsule immediately surrounding the parasite; the surface of this capsule is smooth and glistening, and entirely separated

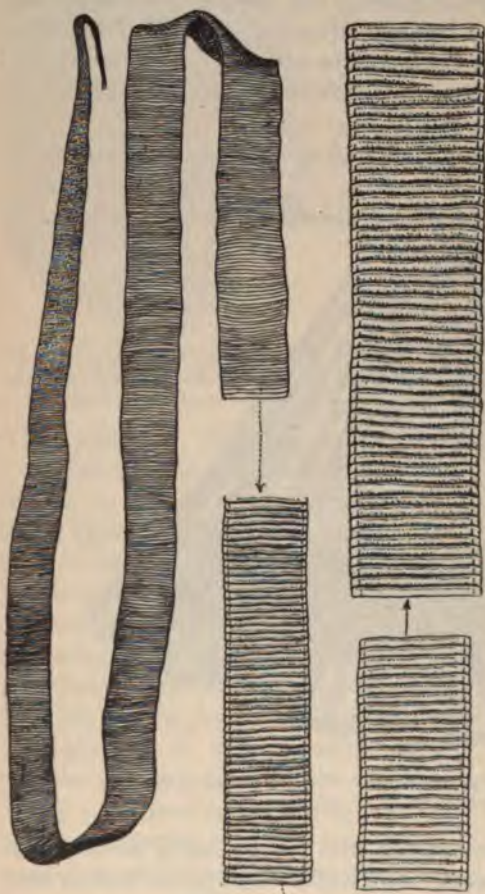


FIG. 111.—Portions of an adult Flat *Moniezia* (*Moniezia planissima*). (After Stiles & Hassall, 1893, Pl. I, fig. 1). See p. 127.

from the cuticle of the cyst, so that with care the parasite may be freed without injury; the capsule grows in thickness from 1 to 10 mm. After a time the cysts may undergo degeneration; the entire body may be replaced by a caseous or gelatinous amorphous mass in which hooks or remnants of the cuticle may be found. The multilocular echinococcus presents an appearance differing from that of the ordinary form and resembling a cauliflower to some extent.

Differential diagnosis.—In post-mortem examination, hydatid disease, especially of the lungs, may occasionally be mistaken for tuberculosis, more particularly when the hydatids are very young and numerous, or degenerated; in tuberculosis, however, (1) the neighboring¹ lymphatics will generally be involved, which is not the case in hydatid disease, while (2) in hydatid disease the parasite is generally easily separated from its surrounding capsule, (3) the elastic cuticular membrane is lamellated, and (4) a microscopic examination will in some cases show the hooks of the heads. See also p. 79.

Treatment.—It is useless to waste time in trying to treat a domesticated animal in which echinococcus is suspected unless the animal is an especially valuable one, and unless the parasite is located in an organ which can be reached by surgical interference.

A number of methods for treatment in man have been suggested from time to time, but surgical interference is the only one which has been followed by satisfactory results. For a discussion of this subject with citation of cases, see Davaine (1879, pp. 592-663).

Prevention.—Keep dogs away from slaughterhouses. This will prevent their becoming infected with the tapeworms, and thus prevent their transmitting the parasite to man and animals. Stray dogs should be killed; all other dogs should be looked upon as suspicious characters, and should not be accorded the privileges of human beings.



FIG. 112.—Three views of heads of the Flat *Moniezia* (*Moniezia planisima*). $\times 17$. (After Stiles & Hassall, 1893, Pl. I, figs. 2-25.) See p. 127.

ABATTOIR INSPECTION.

Organs infested with echinococcus are not directly harmful to man as food, since the parasite will not come to maturity in man's intestine, and there is no objection to placing these organs on the market after the portion containing the parasite has been removed. Removing and destroying the infected portions are precautions which should always be taken in order to prevent the possibility of the further infection of dogs.

The abattoir is the proper place to attack this disease, and a careful and persistent destruction of the larval stage found in meat inspection must finally result in lessening and even exterminating the disease. Heat should be used in destroying the parasite.

Frequency of the hydatid in various animals.—The frequency of hydatid varies greatly in different countries. According to statistics thus far published the parasite appears to be most frequent in Iceland, India, Eastern Siberia, and Australia; it is more common in Mecklenburg

¹ An infection of the lymphatics (fig. 110) with the so-called "Tongue worm" (*Linguatula rhinaria*) should not be mistaken for tuberculosis.

than in any other part of continental Europe. The United States seems to be comparatively free from hydatid infection, although the disease is apparently on the increase.

United States.—I have seen cases of hydatids in this country in cattle, hogs, the camel, and man, but as yet have seen no cases in sheep. Wheeler records 117 cases of liver echinococcus in 2,000 hogs examined at New Orleans; the cases in domesticated animals which I have examined came from the District of Columbia, Missouri, and Nebraska; Welch records it for Maryland and several of the Bureau inspectors report it for various abattoirs. (For the cases in man, see p. 124.)

Iceland.—The statistics for Iceland are not altogether satisfactory, but it is alleged that in some districts every sheep of three years old is infested, while it is an exception to find a cow ten years old which is free from this parasite; in some districts it is estimated that about one-third of the sheep are infested; one author estimates that one-fourth are infested.

India.—Seventy per cent of the cattle are infested (Neumann).

Germany.—The statistics for Germany are more detailed than for any other country; it must, however, be borne in mind that while some

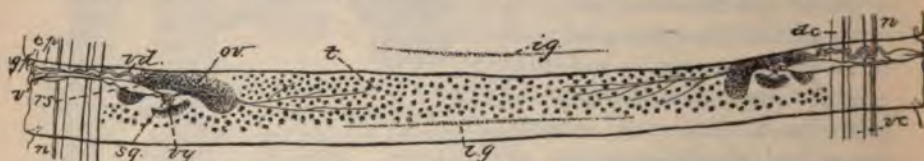


FIG. 113.—Dorsal view of sexually mature segment of the Flat *Moniezia* (*Moniezia planissima*): *cp*, cirrus pouch; *dc*, dorsal canal; *gp*, genital pores; *ig*, interproglottidal glands; *n*, nerve; *ov*, ovary; *rs*, receptaculum seminis; *sg*, shell gland; *t*, testicles; *v*, vagina; *vc*, ventral canal; *vd*, vas deferens; *vg*, vitellogene gland. Enlarged. (After Stiles & Hassall, 1893, Pl. II, fig. 4.)

German statistics include the whole number of animals slaughtered and the entire number of cases found, other statistics leave out the calves and omit from the list those cases of light infection in which the portion containing the parasite could be excised and the rest of the organ placed upon the market. The following statistics are compiled from various sources:

Peiper (1894) takes the statistics of 52 slaughterhouses in various parts of Germany and concludes that 10.39 per cent of the cattle, 9.83 per cent of the sheep, and 6.47 per cent of the hogs harbor hydatids; the average for Greifswald, Wolgast, Auklam, Demmin, and Swinemünde (Vorpommern) was: Cattle, 37.73 per cent; sheep, 27.1 per cent; hogs, 12.8 per cent; for Greifswald alone, cattle, 64.58 per cent; sheep, 51.02 per cent; hogs, 4.93 per cent.

Mecklenburg.—About half of the animals are infested (Sahlmann). Cows infested to 25 per cent, sheep 15 per cent, hogs 5 per cent (Metelmann).

Stettin.—Cows (293:1425), 7.1 per cent; hogs (1238:16829), 7.3 per cent; sheep (3807:14717), 25.8 per cent (Olt).

Leipzig (one year).—Sheep (591:4515), 13.09 per cent; native hogs (196:5166), 3.79 per cent; Hungarian hogs (181:843), 27.47 per cent. In native hogs the liver (3.81 per cent) was more frequently infected than the lungs (0.26 per cent); in Hungarian hogs liver, 12.03 per cent; lungs, 14.79 per cent; in sheep the lungs (12.71 per cent) were more frequently infested than the liver (3.73 per cent). (Mejer.)

The *Berlin* statistics (quoted from Braun, 1895, who takes them from the *Berichte über die städtische Fleischschau in Berlin*) are especially instructive; they are here reduced to percentages in order to bring out the results more prominently:

Number of organs of cattle, sheep, and hogs condemned for hydatids from 1888 to 1893.

CATTLE (CALVES NOT INCLUDED).

Year.	Number examined.	Condemned for hydatids.			
		Lungs.		Livers.	
		Number.	Per cent.	Number.	Per cent.
1888-89	141,814	6,578	4.6	2,668	1.8
1889-90	154,218	7,266	4.7	2,418	1.5
1890-91	124,593	5,792	4.6	1,938	1.5
1891-92	136,368	4,497	3.2	1,721	1.2
1892-93	142,874	2,563	1.7	739	.5

SHEEP.

1888-89	338,798	5,041	1.4	3,363	0.9
1889-90	430,362	5,479	1.2	2,742	.6
1890-91	371,943	4,595	1.2	2,059	.5
1891-92	367,933	4,435	1.2	1,669	.4
1892-93	355,949	3,331	.9	1,161	.3

HOGS.

1888-89	479,124	5,910	1.2	5,285	1.1
1889-90	442,115	6,523	1.4	5,078	1.1
1890-91	472,859	5,083	1.07	3,735	.07
1891-92	530,551	6,037	1.1	4,374	.08
1892-93	518,073	6,785	1.3	4,312	.08

1893-94 in all 13,424 lungs and 6,283 livers. (*Berichte ü. d. städtische Vieh- u. Schlachthf.*)

These statistics show that from 1888-89 to 1892-93 there has been a reduction in the number of organs condemned for hydatids both in cattle and sheep, which must be attributed to the system of abattoir inspection, and which must necessarily result in a corresponding decrease in hydatid disease in man. This reduction is not so apparent among hogs, but it must not be forgotten that Berlin slaughters large numbers of hogs imported from districts in which the slaughterhouse inspection is exceedingly superficial. We saw above that some German importations of hogs from Russian Poland, Bohemia, etc., were infected with *Cysticercus cellulosae* to 50 per cent, and hogs which are kept in such a manner as to allow this infection will certainly also bring up the German statistics of hydatids. I am strongly inclined to give much greater importance to the Berlin statistics than appears from the percentages of infection among the hogs.

THE ADULT TAPEWORM IN DOGS.

(See p. 101.) It seems to me entirely impracticable to attempt to guard against hydatid disease by trying to definitely diagnose the presence of the adult worms in dogs. If, however, the worm is found in

dogs, the latter should be killed and burned. The hydatid is altogether too dangerous a parasite in man to warrant a person's treating a dog which harbors *Taenia echinococcus*.

A decision of the "Professoren-Kollegium des Tierarznei-Instituts zu Brüssel," though amusing to Americans, is of great importance to any country in which canine flesh is used as food; that is, that the oesophagus, stomach, and intestine of all slaughtered dogs are to be excluded from the market.

HYDATID DISEASE IN MAN.

It is important to consider this subject in this connection in order to insist upon the necessity of destroying hydatids found at abattoirs. Hydatid disease is the most fatal zoo-parasitic disease which affects man, "50 per cent of the cases dying within five years after infection," but its occurrence in man is fortunately comparatively rare in this country. One of the volunteer assistants in the Bureau, Dr. H. O. Sommer (1895-96), has recently compiled 100 cases which have been found in the United States. Many of the cases were among foreigners, and some of these were certainly infested before coming to this country.

The 100 cases in the United States were distributed as follows:

BY NATIONALITY.

Nationality.	Cases.	Nationality.	Cases.	Nationality.	Cases.
Azorian	1	Italian	5	Welsh	1
"Colored"	1	Japanese	1	"White"	4
English	5	Mexican	1	Unstated	54
"Foreigners"	2	"Mulatto"	2		
French	2	Negro	2	Total	100
German	15	Pole	1		
Irish	2	Swede	1		

By sex: Males, 47; females, 28; unstated, 25.

BY STATES.

State.	Cases.	State.	Cases.	State.	Cases.
Alabama	2	Louisiana	1 (or 2?)	Pennsylvania	10
California	1	Massachusetts	5 (or 6?)	Tennessee	1
Connecticut	1	Missouri	7	Texas	1 (+?)
District of Columbia	4	Michigan	1	Vermont	1
Illinois	3	New Jersey	1	Virginia	2
Indiana	1	New York	33	Washington	1
Kentucky	2	Ohio	7	Unstated	15

Of 981 cases from various parts of the world, the greatest number occurred in persons between 21 and 40 years of age, as shown by the following classification by ages:

Years.	Cases.	Years.	Cases.
0 to 10	54	51 to 60	82
11 to 20	152	61 to 70	36
21 to 30	274	71 to 80	18
31 to 40	225	Over 80	2
41 to 50	138		

In man the organs most frequently infested are the liver, lungs, kidneys, and cranial cavity. Thus, of 1,806 cases of organ infections, the liver was infested in 1,011 cases, lungs in 147, kidneys in 126, and cranial cavity in 95.

Hydatid disease is especially common in Iceland and Australia. For Iceland the statistics are very contradictory, some authors estimating that 2 per cent, others 16 $\frac{2}{3}$ per cent (probably exaggerated), of the inhabitants are infested. Three thousand cases are reported for Australia between 1861 and 1882.

In central Europe the hydatid is found on an average once in every 130 post-mortems. The frequency varies in different localities, Mecklenburg and Pomerania leading the list. Ostertag gives the following statistics:

Locality.	Cases.	Post-mortems.	Per cent.
Rostock	25	1,025	2.43
Breslau	20	1,360	1.47
Berlin	33	4,470	0.76
Göttingen	3	639	.46
Dresden	7	2,002	.34
Vienna	3	1,229	.24
Prague	3	1,287	.23
Erlangen	2	1,812	.11

Peiper collected 150 cases for Vorpommern from 1860 to 1890; in post-mortems at the Pathological Institute of Greifswald the percentage was 1.9.

Prevention of the disease in man.—The disease may be prevented in three ways—

(1) By recalling that the dog is not a human being and should not be treated as one. Too intimate association with dogs is sure to breed the disease in man.

(2) By preventing infection among dogs. This can be done by keeping dogs away from slaughterhouses, and by the destruction (by heat) of all hydatids found in slaughtered animals. The slaughterhouse is the best place to institute measures against hydatid disease in man.

(3) By killing all stray and ownerless dogs.

Adult Tapeworms of Cattle and Sheep (Subfamily *Anoplocephalinae*).

Adult tapeworms are more or less frequently found in the intestines of cattle and sheep, more rarely in the bile duct of sheep. As stated on page 68, they all belong to the subfamily *Anoplocephalinae*; they are very closely related to the tapeworms of horses, hares, and rabbits, and yet are entirely distinct from these forms.

Owing to many misidentifications of tapeworms which have been published, and to the meagre descriptions of some of the species, it is impossible to state exactly how many different forms actually occur in cattle and sheep, but we are now in a position to clearly define the most common forms which occur, especially those which are found in this country, and to suppress some of the worms which have been

described as distinct species of parasites in these animals, but which in reality are identical with forms previously described under other names, or are parasites erroneously attributed to these hosts.

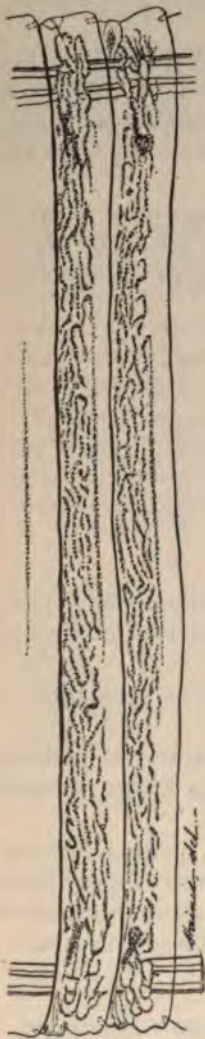


FIG. 114.—Dorsal view of gravid segments of the Flat *Moniezia* (*Moniezia planissima*), showing the uterus, enlarged. (After Stiles & Hassall, 1893, Pl. II, fig. 5.)

S. globipunctata, occur in sheep in other countries. *Moniezia denticulata* (= *Cittotaenia denticulata*) of the rabbit has erroneously been reported from sheep in Europe.

Swine.—No species of adult tapeworm is positively known to be a normal parasite in swine, but Cholodkowsky (1894, pp. 552–554) records

Cattle.—Eight different species of tapeworm have been reported from cattle, but in all probability only four of them are found in this host; these four species all belong to the genus *Moniezia*, and two of them, namely, *Moniezia planissima* and *M. expansa*, are found in this country.

This Bureau has knowledge of only two adult tapeworms in American cattle, but I have examined specimens of three other species, namely, *Moniezia alba*, *M. Benedeni*, and *M. denticulata*, preserved in various European collections and bearing the label that they were taken from cattle. Of these three forms, *M. denticulata* (= *Cittotaenia denticulata*) is unquestionably a parasite of rabbits instead of cattle (Stiles & Hassall, 1896), and an error must have been made in the original label; *M. alba* and *M. Benedeni* are evidently legitimate cattle parasites. Rivolta (1878) states that he examined a tapeworm collected by Perroncito from the ox which he (Rivolta) considered identical with a worm he at first labeled "*Taenia denticulata* (?)" and which he later described as *Taenia ovilla* (= *Thysanosoma Giardi*). Perroncito has, however, recently stated to Lungewitz (1895, p. 6) that he found this worm only in sheep. *Thysanosoma Giardi* is accordingly not yet established as a bovine parasite. Von Linstow (1889, p. 20) includes two other tapeworms, namely, *Stilesia centripunctata* and *S. globipunctata*, as parasites of cattle, but I am unable to find the authority for this statement.

Sheep.—A large number of tapeworms have been described or recorded as parasites of sheep, but the number of species must be considerably reduced, for some of the forms described as distinct species are identical with forms previously described under other names, while other forms were misdetermined. Four species, namely, *Moniezia planissima*, *M. expansa*, *M. trigonophora*, and *Thysanosoma actinioides*, are known to occur in American sheep.

Several other forms, namely, *Moniezia alba*, *M. Benedeni*, *M. Neumanni*, *M. nullicollis*, *M. Vogti*, *Thysanosoma Giardi*, *Stilesia centripunctata*, and



FIG. 115.—Egg of the Flat *Moniezia* (*Moniezia planissima*), greatly enlarged. (After Stiles & Hassall, 1893, Pl. II, fig. 6.)

specimens of *Thysanosoma Giardi* said to have been taken from hogs in Russia, and Detmers (1879), and Stiles (1895, pp. 220-222) have recorded three cases of other forms alleged to have occurred in this country.

The three genera of adult tapeworms for us to consider in connection with cattle, sheep, and swine are *Moniezia*, *Thysanosoma*, and *Stilesia*.

For a technical discussion of these genera and their species, with bibliographies, see Stiles & Hassall (1893) and Stiles (1896). For convenience of discussion, all of the forms will be treated together. For anatomical characters, compare figs. 111-124 with the key, page 21.

GENUS MONIEZIA.

It is often quite difficult to distinguish between the different forms, as the specific characters must to a great extent be taken from the internal anatomy, and it is therefore necessary to make a microscopic examination of one or more specimens which have been artificially stained. In many cases, however, these characters may be recognized if a fresh worm is allowed to macerate one or two days in water; then by pressing some of the segments between two pieces of glass and holding them to the light some of the internal anatomy can be recognized.

24. The White *Moniezia* (*Moniezia alba*) of Cattle and Sheep.

SYNONYMY.—*Taenia alba* Perroncito, 1879; *Moniezia alba* (Perroncito) R. Blanchard, 1891; (?) *M. alba* var. *dubia* Moniez, 1891.

This tapeworm has been recorded for France, Italy, and Algeria, but not as yet for this country. Poorly preserved specimens of *M. planissima* resemble this form in that the interproglottidal glands can not be seen distinctly. This renders it possible that *M. alba* is simply a poorly preserved *M. planissima*—a point which can not, however, be demonstrated by a comparison of the original types; on this account, it is necessary to retain both species.

25. Vogt's *Moniezia* (*Moniezia Vogti*) of Sheep.

SYNONYMY.—*Taenia Vogti* Moniez, 1879; *Anoplocephala Vogti* (Moniez) Moniez, 1891; *Moniezia Vogti* (Moniez) Stiles & Hassall, 1896.

Very little is known about this supposed species, which may be a distinct form or may be a dwarfed specimen or some other species. It has been found once in France and once in England, but is not yet recorded for America.

26. The Flat *Moniezia* (*Moniezia planissima*) of Cattle and Sheep.

[Figs. 111-115.]

SYNONYMY.—*Moniezia planissima* Stiles & Hassall, 1892; *Taenia* (*Moniezia*) *planissima* (Stiles & Hassall) Braun, 1895; *T. expansa* pro parte of various authors.

This seems to be the most common adult tapeworm in American cattle; it also



FIG. 116.—Portions of an adult specimen of the Broad *Moniezia* (*Moniezia expansa*), natural size. (After Stiles & Hassall, 1893, Pl. VI, fig. 1.)

occurs in American sheep, but is apparently not so common in this host. It is found also in France, Germany, and Italy.

27. Van Beneden's Moniezia (*Moniezia Benedeni*) of Cattle and Sheep.

SYNONYMY.—*Taenia Benedeni* Moniez, 1879; *Moniezia Benedeni* (Moniez) R. Blanchard, 1891.

This worm was recorded once for sheep in France and once for cattle in Austria.

28. Neumann's Moniezia (*Moniezia Neumanni*) of Sheep.

This worm was described by Moniez in 1891, and has been recorded only once. It was found in France.

29. The Broad Moniezia (*Moniezia expansa*) of Cattle, Sheep, Goats, etc.

[Figs. 110-119.]

SYNONYMY.—? *Taenia ovina* Goeze, 1782; ? *Halysis ovina* (Goeze) Zeder, 1803; ? *T. expansa* Rudolphi, 1805 (nomen nudum); *T. expansa* Rudolphi, 1810; *Alyselminthus expansus* (Rudolphi) Blainville, 1828; *Moniezia expansa* (Rudolphi) R. Blanchard, 1891; *Taenia* (*Moniezia*) *expansa* of Braun, 1895.

This worm is quite common in America and Europe, both in cattle and sheep.

30. The Triangle Moniezia (*Moniezia trigonophora*) of Sheep.

[Figs. 120-121.]

SYNONYMY.—*Moniezia trigonophora* Stiles & Hassall, 1893; *Taenia* (*Moniezia*) *trigonophora* (Stiles & Hassall) Braun, 1895. Also *T. expansa* and *T. Benedeni* pro parte of some authors.

This is rather a common parasite of American sheep, and is also found in France. It takes its name from the triangular arrangement of the testicles. I have seen one serious outbreak of disease in sheep due in part to this parasite and in part to the twisted wireworm (*Strongylus contortus*) of the stomach.

Genus THYSANOSOMA.

Represented by one species in North America and South America and one species in Europe.

31. The Fringed Tapeworm (*Thysanosoma actinioides*) of Sheep, Deer, etc.

[Figs. 122-124.]

SYNONYMY.—*Thysanosoma actinioides* Diesing, 1835; *Taenia fimbriata* Diesing, 1850 [nec Batsch, 1786]; "*Taenia expansa*" misdet. pro parte, of Faville, 1885; *Moniezia fimbriata* (Diesing) Moniez, 1891.

The Fringed Tapeworm is found in North America and South America, and forms at times a veritable scourge to the sheep industry of the Western plains.

Disease.—The disease in sheep caused by the Fringed Tapeworm has been studied in detail by Curtice (1890, pp. 91-109), who considers that next to scab it is the most important sheep disease of the Western plains. The financial loss it causes is quite extensive, and results from the failure of the lambs to fatten, the lessening of the wool, and the weakening of the animals so that they can not withstand the cold winter weather. The parasites develop slowly, and are present in considerable numbers before their presence is suspected. Toward September the lambs fail to grow as they should; in November the symptoms are

quite marked. First, the worms produce a local irritation of the intestine, which finally develops into a chronic catarrhal inflammation; their presence in the gall ducts produces similar results and obstructs the flow of bile; infected lambs are large headed, undersized, and hide-bound; their gait is rheumatic and they appear more foolish than the other sheep, standing oftener to stamp at the sheep dogs or herders, and lagging behind the flock when driven; the general symptoms are those of malnutrition, and Curtice considers them nearly identical with the symptoms of the loco disease; in fact, he states that it is extremely difficult to distinguish between the two diseases, and believes that the fact that the worms

"may tend to produce depraved appetites and a morbid craze for a particular food is also reason for suspecting that the loco disease may depend on the tapeworm disease." General systematic disturbances result from malnutrition; the usual fat is absent; serous effusions are noticed in the body cavities, serous infiltration in the connective tissue.

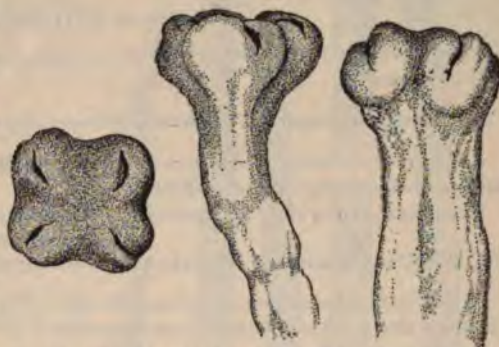


FIG. 117.—Three views of the head of the Broad *Moniezia* (*Moniezia expansa*). $\times 17$. (After Stiles, 1893, Pl. V, figs. 1-1b.) See p. 128.



FIG. 118.—Sexually mature segments of the Broad *Moniezia* (*Moniezia expansa*): *cp*, cirrus pouch; *ig*, interproglottidal glands; *rs*, receptaculum seminis; *sg*, shell gland; *t*, testicles; *v*, vagina; *vg*, vitellogene gland. Enlarged. (After Stiles, 1893, Pl. VI, fig. 4.) See p. 128.

Treatment.—Curtice found that powdered preparations of pumpkin seed, pomegranate-root bark, cusso, kamala, male fern, and worm seed were of no avail, a failure due, he maintains, to the anatomical structure of the sheep's stomach and method of administration; no medicine could be used to dislodge the parasites from the gall ducts.

Personally, I have never treated sheep for the Fringed Tapeworm, but I would suggest the advisability of trying the method described on pp. 133-135.

32. Giard's *Thysanosoma* (*Thysanosoma Giardi*) of Cattle(?), Sheep, and Swine(?).

SYNONYMY.—*Taenia ovilla* Rivolta, 1878 [nec Gmelin, 1790]; *T. Giardi* Moniez, 1879; *T. aculeata* Perroncito, 1882; *Moniezia ovilla* (Rivolta) Moniez, 1891; *M. ovilla* 5257—No. 19—9

var. *macilenta* Moniez, 1891; *Thysanosoma Giardi* (Moniez) Stiles, 1893; *Th. ovilla* (Rivolta) Railliet, 1893; *Taenia Brandti* Cholodkowsky, 1894; *Th. ovillum* (Rivolta) Railliet, 1895.

This peculiar tapeworm has been found in sheep in France, Italy, Germany, and Russia, and has been recorded once in hogs; its occurrence as a normal parasite in both hogs and cattle is doubtful. (See pp. 126-127.)

Genus STILESIA.

Two species of this genus are found in sheep, but neither form is yet recorded for this continent.

33. The Globipunctate *Stilesia* (*Stilesia globipunctata*) of Cattle(?) and Sheep.

SYNONYMY.—*Taenia globipunctata* Rivolta (1874); *T. oripunctata* Rivolta (1874); *Stilesia globipunctata* (Rivolta) Railliet, 1893.

Found in sheep in Italy and India; its occurrence in cattle is doubtful. (See p. 126.)

34. The Centripunctate *Stilesia* (*Stilesia centripunctata*) of Cattle(?) and Sheep.

SYNONYMY.—*Taenia centripunctata* Rivolta (1874); *Stilesia centripunctata* (Rivolta) Railliet, 1893; *Taenia* (*Stilesia*) *centripunctata* of Braun, 1895.

Found in sheep in Italy and Algeria; its presence in cattle is doubtful. (See p. 126.)



FIG. 119.—Gravid segment of the Broad Moniezia (*Moniezia expansa*), enlarged. (After Stiles, 1893, Pl. VI, fig. 6.) See p. 128.

Life history.—Nothing is positively known about the life history of any of the adult tapeworms of cattle or sheep; but from analogy we may assume that the life cycle is similar to that of other cestodes, namely, that the parasite runs through two stages—the adult form, in the intestine of cattle and sheep, and a larval state (a cysticercus or a cysticercoid), which will be found as a parasite in an intermediate host, probably some invertebrate animal, as an insect, snail, or worm. The intermediate host will become infected from the eggs in the faeces of the cattle and sheep, and the latter will become infected by accidentally swallowing the intermediate host.

While this is what seems to us at present as the probable life history of the bovine and ovine tapeworms, it must be distinctly remembered that no one has as yet been able to positively make out the complete life cycle. In fact, some authors (Curtice and others) do not think that it is necessary for these worms to pass through any intermediate host, but they believe that the embryos (in the eggs) are swallowed by the cattle and develop directly into adult worms. This theory, however, is contrary to analogy, and although this Bureau has repeatedly attempted

to infect animals in the manner indicated, none of the experiments can be looked upon as supporting Curtice's views, for we were unable to produce an infection.

One of the following experiments, given as illustrations, might at first sight seem to support Curtice's theory, but can equally well be explained otherwise:

(1) *September 2, 1891.*—A 6-months-old lamb fed with thousands (!) of eggs of *M. expansa*.

October 2.—Experiment animal showed ripe proglottids in droppings. The infection, however, was totally out of proportion to the number of embryos fed, so that the lamb must have become infected in some other way.

(2) *September 10.*—Lamb fed with thousands of eggs of *M. expansa* at three different times within a week.

September 30.—Lamb killed and four-hour post-mortem held. Intestinal villi, etc., examined microscopically. Result totally negative.

(3) *September 10.*—Lamb fed with thousands of eggs of *M. expansa* five times within a week. Result negative.

Experiments by Curtice and European authors must also be considered as negative, for according to the published accounts of the infections the possible sources besides direct ingestion of eggs were not sufficiently controlled.

TAPEWORM DISEASE OF CATTLE AND SHEEP.

For disease caused by the Fringed Tapeworm, see page 128.

Source of infection.—It will be impossible to make any definite statements upon this point until the complete life history of the worms is known.

Occurrence.—Tapeworms are found in cattle and sheep of all ages and at all times of the year, but calves, lambs, and yearlings suffer more

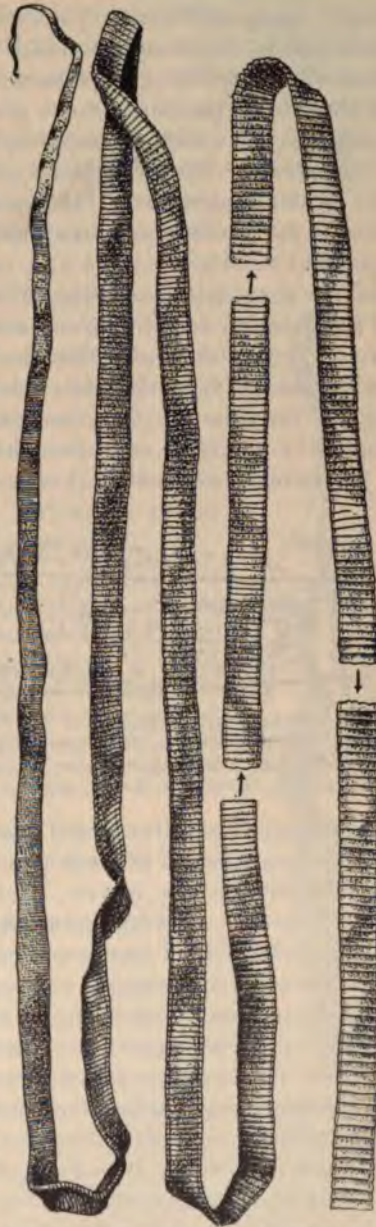


FIG. 120.—Portions of an adult specimen of the Triangle Moniezia (*Moniezia trigonophora*), natural size. (After Stiles & Hassall, 1893, Pl. VIII, fig. 1.) See p. 128.

from the effects of the parasites than do older animals. They are occasionally found in animals in stalls, but are more frequent in animals which are in pasture, and are not so frequent in the winter and early spring as in the summer and fall. Worms (*M. expansa* or *M. planissima*) from 6 to 15 feet long have been found in lambs two to four months old, so that these parasites must grow to maturity very rapidly. Curtice computes the average growth at about 1 yard per month.

Symptoms.—There can be no question that sheep and cattle may harbor a small number of tapeworms with comparatively little or no ill effects, for these worms are found at abattoirs in sheep which are in excellent condition at the time of slaughter. The younger the animal and the greater the infection with worms, the more serious the effects of the disease; but if able to pass through a certain period the animals are very apt to recover, for the worms seem to shed their segments quite suddenly, leaving the hosts with but small tapeworm strobila, and by the time the parasites again attain a greater length the animals may have gained in condition and strength to withstand the disease.

Tapeworms affect their hosts in several ways. By assimilating the



FIG. 121.—Sexually mature segments of the Triangle Moniezia (*Moniezia trigonophora*): cp, cirrus pouch; dc, dorsal canal; ig, interproglottidal glands; n, nerve; ov, ovary; rs, receptaculum seminis; sg, shell gland; t, testicles; v, vagina; vc, ventral canal; vd, vas deferens; vg, vitellogene gland. Enlarged. (After Stiles & Hassall, 1893, Pl. IX, fig. 4.) See p. 128.

nourishment in the intestinal tract of their hosts, they rob the latter of food; when present in large numbers, they may cause stoppage of the bowels, irritate the bowels, leading to non-assimilation of food and reflexly to the nervous symptoms. The clinical history is not very clearly defined from infection with other intestinal parasites, especially with the twisted strongyle (*Strongylus contortus*).

As the animals lose flesh, become poorer, and hidebound, their gait becomes unsteady, the fleece becomes dry and harsh, little yolk being present; the appetite and thirst may increase; diarrhœa is frequent in severe infections, and becomes more pronounced as the disease advances. The animals may at last become completely exhausted and die.

Diagnosis.—Suspicion of tapeworm disease being aroused by the general poor condition of the animals, a positive diagnosis may frequently be made by finding the cast-off segments in the droppings, or around the anus under the tail. A microscopic examination of the faeces for eggs is practicable only for experts. In case of death of one of the flock, it is best to make a careful post-mortem, examining the fourth stomach for the twisted strongyle and the intestines for tapeworms. This can easily be done by opening the intestine in a tub of warm water.

*Treatment.*¹—The first thing to do in treating sheep and cattle for tapeworms is to confine the animals in a comparatively small yard and to withhold solid food the night before dosing. The animals should be kept confined until the worms are passed, then all the faeces should be collected and burned, or buried in quicklime.

Schwalenberg reported good results with kamala, dose for a lamb 3.75 grams (about 1 dram); also with cusso (kousso), dose for a lamb 7.5 grams (nearly 2 drams); still better results with kosin (koussin), dose for a lamb 12 centigrams.

Picric acid, dose 0.6 to 1.25 grams (10 to 20 grains), made into pills with meal and water, is recommended by some authors. It should be followed with a cathartic (a 4-ounce dose of Epsom salts or a 4-ounce dose of any of the bland oils).

Two-ounce dose of powdered male fern root, or, still better, the ethereal oil of male fern in dram doses, is recommended by some veterinarians. It can be given in combination with 2 to 4 ounces of castor oil.

Fröhner (1889) gives the following recipes: Take koussin, 3 grains, and of sugar 10 grains, mix, and give at one dose. The dose of tansy is from 2 to 6 drams. It forms one of the chief ingredients of Spinola's worm cake, which is fed to lambs as a preventive against worms. The recipe, sufficient for 100 sheep, is as follows: Take of tansy, calamus root, and tar, each 2½ pounds; of cooking salt, 1½ pounds; mix these with water and meal, make into cakes, and dry. This is an old and oft-repeated recipe, but I can not vouch for its efficiency. (Curtice, 1890.)

Powdered areca nut may be given to lambs in doses of 1 to 3 drams. If no passage occurs, follow in three or four hours with a cathartic.

In the recent experiments with bluestone by Hutcheon, in South Africa, against wireworm disease in sheep, it has been found that the same treatment expels tapeworms.

Caution.—Repeated accidents have happened from using too strong a solution or too large doses, or in giving it in such a way that the medicine gains access to the lungs. Dr. Hutcheon's method of procedure, which is here given in detail, is safe in the hands of the average farmer if the directions are followed. The person who gives stronger doses than indicated, or who is careless about the measurements, must take the entire responsibility of the miscarriage of the treatment. It is a good plan to make up a smaller quantity of the solution and try it upon a few sheep before attempting to dose the entire flock.



FIG. 122.—A adult specimen of the Fringed Tapeworm (*Thysanosoma actinioides*). (After Stiles, 1893, Pl. XI, fig. 1.) See p. 128.

¹In this connection consult Curtice, 1890, pp. 120-121.

(a) *To prepare the mixture.*—Hutcheon has changed his formula slightly from time to time, the latest published proportions (February 21, 1895) reading as follows (see footnote, p. 136):

Dissolve 1 pound *avoirdupois* (1 pound = 16 ounces) of good, commercial, powdered bluestone (sulphate of copper) in 2 *imperial* quarts (= $2\frac{2}{3}$ quarts U. S.) of boiling water; when the bluestone is *thoroughly* dissolved add $6\frac{1}{2}$ *imperial* gallons (= 26 *imperial* quarts = $7\frac{1}{3}$ U. S. gallons = $31\frac{1}{3}$ U. S. quarts) of cold water, making in all 7 *imperial* gallons (or $8\frac{2}{3}$ U. S. gallons) of water. (See footnote, p. 136.)

Use only bluestone which is of a uniform blue color; avoid that which is in conglomerate lumps with white patches and covered with a white crust.

The *equivalents* of 1 pound *avoirdupois* and of 7 *imperial* gallons in other weights and measures are as follows:

One pound *avoirdupois* = 1 pound 2 ounces 280 grains of *apothecaries'* or of *imperial troy* weight = 453.59 grams of *metric* weight.

Seven *imperial* gallons = 8 gallons 3 pints 3 fluid ounces 3 fluid drachms 56 minims (or practically 8 gallons $3\frac{1}{2}$ pints, or $8\frac{1}{2}$ gallons) of *apothecaries'* or *wine* measure, U. S. = 31.804409 liters (practically 31 $\frac{1}{4}$ liters) *metric* system.



FIG. 123.—Ventral and apex views of the head of the Fringed Tapeworm (*Thysanosoma actinioides*). $\times 17$. (After Stiles, 1893, Pl. XI, figs. 2 and 2 b.) See p. 120.

The farmer is cautioned against guessing at the weights and measures, for this is sure to result in too strong a solution, which will kill his animals, or too weak a solution, which will fail to be effective. Scales and measures should be tested before

they are used. If reliable scales are not at hand, buy the bluestone already weighed and have the exact weight in *avoirdupois*, *apothecaries'*, or *metric* system marked on the package.

If a smaller quantity than the above is desired, this can be made up on the proportion of 1 ounce *avoirdupois* of bluestone to $4\frac{1}{2}$ U. S. pints of water.

(b) *Preparation of the animals.*—Fast the sheep or cattle twenty to twenty-four hours before dosing. If the fast is thirty hours (longer fasts are dangerous) an extra half gallon or a gallon of water should be added to the solution, as animals are more liable to suffer after a long fast.

(c) *Size of the dose.*—Hutcheon has several times changed the size of the doses he advises, in some papers basing it on the *imperial* fluid ounce, in others on the tablespoon. The doses for sheep (in *imperial* ounces and in tablespoons) given below are his most recent (January 10, 1895) recommendations, and though based upon a solution with 5 per cent less water than the solution given above, they may be used for the weaker mixture.

We have given several of the *metric* doses to sheep on the Bureau

Experiment Station, and the sheep showed no ill effects; on the contrary they gained in weight. (See footnote, p. 136.)

Age of animals.	Approximate equivalents.			
	Table- spoons. <i>a</i>	Imperial.	U. S. apothecaries.	Metric.
For a lamb 3 months old.....	1	About $\frac{3}{4}$ fluid ounce.	About $\frac{3}{4}$ fluid ounce.	About 20 cc.
For a lamb 6 months old.....	2	About $1\frac{1}{2}$ fluid ounces.	About $1\frac{1}{2}$ fluid ounces.	About 40 cc.
For a sheep 12 months old.....	3	About $2\frac{1}{2}$ fluid ounces.	About 2 fluid ounces.	About 60 cc.
For a sheep 18 months old.....	4	About 3 fluid ounces.	About $2\frac{1}{2}$ fluid ounces.	About 80 cc.
For a sheep 24 months old.....	$4\frac{1}{2}$	About $3\frac{3}{4}$ fluid ounces.	About 3 fluid ounces.	About 90 cc.
For a calf 3 months old.....	$4\frac{1}{2}$ to 5	About $3\frac{1}{2}$ to $3\frac{3}{4}$ fluid ounces.	About 3 to $3\frac{1}{2}$ fluid ounces.	90 to 100 cc.
For a calf 6 months old.....	5 to $5\frac{1}{2}$	About $3\frac{3}{4}$ to 4 fluid ounces.	About $3\frac{1}{2}$ to $3\frac{3}{4}$ fluid ounces.	100 to 110 cc.

a "The tablespoon I refer to is the modern full-sized tablespoon (6 fluid drachms). The medicinal tablespoon contains exactly half an ounce."—HUTCHEON.

Be careful not to give a two-toothed young sheep as much as a full grown four-toothed sheep. Mistakes may occur in judging the age unless the teeth are examined.

The doses should be measured off in bottles and the point of each dose plainly marked with a file.

(*d*) *Dosing*.—In dosing, use long-necked bottles, as castor-oil bottles, Worcester sauce bottles, or anchovy sauce bottles.

Let one person set the sheep on its haunches and take its two forelegs in his left hand, while he steadies the head with the right. Another person inserts the neck of the bottle into the mouth. The head of the sheep should not be raised too high, as in that case the solution may enter the lungs and kill the sheep. A safe rule is to raise the nose to the height of the animal's eyes.

(*e*) *Overdose*.—If, after dosing, any of the sheep seem to be suffering from an overdose, indicated by lying apart from the flock, not feeding, manifesting a painful, excited look and a spasmodic movement in its running, walking with a stiff gait, purging, the discharge being a dirty brownish color, take the affected animals away from the flock to a shady place and dose with laudanum and milk as follows:

For a lamb 4 to 6 months old, 1 teaspoonful of laudanum in a tumbler of milk.

For a sheep 1 year old, 2 teaspoonfuls of laudanum in a tumbler of milk. Repeat half the dose in two to three hours if necessary.

(*f*) *After treatment*.—The animals should not be allowed water for several hours after receiving their dose.

Prevention.—Preventive measures against adult tapeworm infection in sheep and cattle can be given only in the most general terms, as explicit directions can be based only upon a knowledge of the exact source of infection. The general preventive measures applicable to all intestinal parasitic diseases would apply in the case of tapeworm disease, namely: since the parasites are contracted by means of con-

taminated food or drink, prevent this contamination as much as possible; feed high with pure food and water preceding and during the time of greatest infection; avoid overcrowding of pastures; isolate infected stock; and when treating medicinally treat the entire flock if possible.

Contamination of food and drink.—This generally takes place by allowing manure piles to drain into the water supply or into pastures. In the case of adult tapeworms of cattle and sheep some other factors probably come into play.

Feeding pure food and water.—Grain, etc., should be fed from platforms or troughs, which should be kept clean; raised water troughs should be supplied, so that the animals need not be obliged to drink from stagnant pools. These water troughs should be occasionally cleaned. Many



FIG. 124.—Segments of the Fringed Tapeworm (*Thysanosoma actinioides*), showing canals and nerves, and (f) fringed border, (t) testicles, and (ut) uteruses. Enlarged. (After Stiles, 1893, Pl. XI, fig. 8.) See p. 128.

ranchmen have already learned that by feeding their lambs extra grain during the fall, not only have their losses been di-

minished, but the lambs become larger and stronger as well as fatter.

Avoid overcrowding of pastures.—Overcrowding of pastures is one of the surest methods of keeping animals permanently infested with animal parasites, since the chances of infecting the pasture are increased and, by being compelled to graze too close, the animals are more liable to infection from the germs of parasites found on the ground.

Isolation of infected stock.—This is always advisable, no matter what particular disease is present.

¹ *Treatment of the entire herd.*—This is advisable, since all animals which have been subject to infection stand a chance of having contracted disease, even if only in a light form; but light attacks of parasitic diseases serve to reinfect pastures.

ABATTOIR INSPECTION.

The abattoir inspection for tapeworms in the intestines of cattle and sheep is of no importance whatever, since none of these parasites are transmissible to man in any stage of their development. If the drainage of a slaughterhouse is not properly cared for, the surroundings form a concentrated area of infection.

¹ *Addenda to Hutcheon's Bluestone Treatment.*—At the moment of going to press after proof reading was completed, we have received from Hutcheon another article on this subject, dated 1897. He adopts practically the same doses given on p. 135, but changes the strength of the solution (see p. 134) to 1 pound of bluestone to "40 whiskey bottlesful of water." This is practically 1 pound to 7½ imperial gallons (= 9 U. S. gallons = about 34 liters metric) of water.

We wish here to repeat and emphasize the advice given to the farmer on p. 133, to make up a smaller quantity of the solution and try it on a few sheep a few days before the entire flock is dosed. This will give him an opportunity to judge whether he has made a mistake in weights and measures in mixing the solution.

II. COMPENDIUM OF THE PARASITES, ARRANGED ACCORDING TO THEIR HOSTS.

By ALBERT HASSALL.

In the following compendium are included the hosts for all of the parasites discussed in this paper. The numbers of the hosts refer to the numbers in von Linstow's (1878) Compendium. In selecting the scientific names of hosts, I have been guided by the advice of Dr. T. S. Palmer, of the Biological Survey, U. S. Department of Agriculture.

☐ signifies that either Stiles or I have examined the parasite for the host in question in North America.

□ signifies that either Stiles or I have examined this parasite for the host in question, but the specimen was not North American.

? signifies that I doubt the validity of the determination or the validity of the species.

† signifies that I reserve judgment upon the species.

MAMMALS (*Mammalia*).

PRIMATES.

1. *Homo sapiens*. Man.

<i>Dicrocoelium lanceatum</i> , p. 55.....	Liver.
<i>Fasciola hepatica</i> , p. 29.....	Liver.
? <i>Fasciola hepatica angusta</i> , p. 48.....	Lungs.
? <i>Fasciola gigantica</i> , p. 49.....	Lungs.
☐ <i>Schistosoma haematobium</i> , p. 58.....	Veins.
<i>Bothriocephalus cordatus</i> , p. 85.....	Intestine.
☐ <i>Bothriocephalus latus</i> , p. 85.....	Intestine.
<i>Bothriocephalus Mansoni</i> , p. 85.....	Intestine.
☐ <i>Cysticercus cellulosae</i> , p. 89.....	Muscles, eye, and brain.
† <i>Cysticercus tenuicollis</i> , p. 96.....	Omentum.
<i>Davainea madagascariensis</i> , p. 86.....	Intestine.
<i>Dipylidium caninum</i> , p. 86.....	Intestine.
☐ <i>Echinococcus polymorphus</i> , p. 113.....	Especially liver and lungs.
☐ <i>Hymenolepis diminuta</i> (including <i>Taenia flavopunctata</i>), p. 86.....	Intestine.
☐ <i>Hymenolepis murina</i> (including <i>Taenia nana</i>), p. 86.....	Intestine.
<i>Krabbea grandis</i>	Intestine.
☐ † <i>Taenia confusa</i> , p. 85.....	Intestine.
☐ <i>Taenia saginata</i> , p. 71.....	Intestine.
☐ <i>Taenia solium</i> , p. 89.....	Intestine.

Simia faunus.

Cysticercus tenuicollis, p. 96.

14. *Simia inuus*. (See *Macacus inuus*.)

9. *Simia rubra*. (See *Cercopithecus patas*.)

19. *Simia silenus*. (See *Macacus silenus*.)
Semnopithecus entellus. Hanuman langur.
Cysticercus tenuicollis, p. 96.
4. *Cercopithecus cephus*.
Cysticercus cellulosae, p. 89..... Peritoneum.
5. *Cercopithecus cynosurus*. Malbrouck Guenon.
Cysticercus tenuicollis, p. 96..... Liver and mesentery.
6. *Cercopithecus fuliginosus*. Sooty Monkey.
Schistosoma haematobium (Cobbold's *Bilharzia magna*), p. 58..... Veins.
7. *Cercopithecus mona*. Mona Guenon.
Cysticercus tenuicollis, p. 96.
9. *Cercopithecus patas*. Patas Guenon.
Cysticercus cellulosae, p. 89.
10. *Cercopithecus sabaues*. Grivet Guenon.
Cysticercus tenuicollis, p. 96..... Liver and mesentery.
12. *Macacus cynomolgus*. Crab-eating Macaque.
Cysticercus tenuicollis, p. 96..... Liver and mesentery.
Echinococcus polymorphus, p. 113..... Viscera.
14. *Macacus inuus*. Barbary Macaque.
Cysticercus cellulosae, p. 89..... Peritoneum.
Cysticercus tenuicollis, p. 96..... Peritoneum.
Echinococcus polymorphus, p. 113..... Viscera.
19. *Macacus silenus*. Lion-tailed Macaque.
Echinococcus polymorphus, p. 113..... Viscera.
12. *Inuus cynomolgus*. (See *Macacus cynomolgus*.)
14. *Inuus ecaudatus*. (See *Macacus inuus*.)
17. *Papio maimon*. Mandril.
Cysticercus tenuicollis, p. 96..... Liver and mesentery.
17. *Cynocephalus maimon*. (See *Papio maimon*.)

CARNIVORES (*Carnivora*).

191. *Ursus arctos*. Brown Bear.
Cysticercus cellulosae, p. 89..... Muscles.
167. *Vulpes lagopus*. Arctic Fox.
Taenia coenurus, p. 109..... Intestine.
165. *Canis familiaris*. Dog.
Bothriocephalus cordatus, p. 101..... Intestine.
Bothriocephalus fuscus, p. 101..... Intestine.
Bothriocephalus latus, p. 101..... Intestine.
Bothriocephalus serratus, p. 101..... Intestine.
Cysticercus cellulosae, p. 89..... Muscles and peritoneum.
- ☐ *Dipylidium caninum*, p. 102..... Intestine.
- ☐ *Mesocostoides lineatus*, p. 102..... Intestine.
- Taenia coenurus*, p. 109..... Intestine.
- ☐ *Taenia echinococcus*, p. 114..... Intestine.
- ☐ *Taenia Krabbei*, p. 102..... Intestine.
- ☐ *Taenia marginata*, p. 96..... Intestine.
- ☐ *Taenia serialis*, p. 102..... Intestine.
- ☐ *Taenia serrata*, p. 102..... Intestine.
146. *Felis domestica*. Cat.
Dicrocoelium lanceatum, p. 55..... Gall bladder.
Fasciola hepatica, p. 29.
Cysticercus cellulosae, p. 89.
Cysticercus tenuicollis, p. 96.
Echinococcus polymorphus, p. 113.

RODENTS (*Rodentia*).**Lepus californicus.***Coenurus serialis*, p. 102.**Lepus callotis.**☐ *Coenurus serialis*, p. 102.**137. Lepus cuniculus. European Wild Rabbit.***Dicrocoelium lanceatum*, p. 55.*Fasciola hepatica*, p. 29.☐ *Coenurus serialis*, p. 102.† *Coenurus cerebralis*, p. 109.*Echinococcus polymorphus*, p. 113.**137a. Lepus cuniculus domesticus. Common domesticated Rabbit.***Fasciola hepatica*, p. 29..... Liver.† *Coenurus cerebralis*, p. 109..... Muscles.*Coenurus serialis*, p. 102..... Muscles.**140. Lepus timidus. Common European Hare.***Dicrocoelium lanceatum*, p. 55..... Gall bladder.*Fasciola hepatica*, p. 29..... Liver.† *Coenurus cerebralis*, p. 109..... Muscles.*Coenurus serialis*, p. 102..... Muscles.**139. Lepus variabilis. Mountain Hare.***Dicrocoelium lanceatum*, p. 55..... Liver.*Coenurus serialis*, p. 102..... Connective tissue.**Cavia cobaya. Guinea Pig.***Fasciola hepatica caviae*, p. 48..... Liver.**110. Mus rattus. Black Rat.***Cysticercus cellulosae*, p. 89..... Peritoneum.**98. Castor fiber. European Beaver.***Fasciola hepatica*, p. 29..... Liver.**87. Sciurus cinereus.***Cysticercus tenuicollis*, p. 96..... Liver and mesentery.**86. Sciurus vulgaris. European Squirrel.***Fasciola hepatica*, p. 29..... Liver.*Cysticercus tenuicollis*, p. 96..... Liver and mesentery.UNGULATES (*Ungulata*).**206. Elephas indicus. Indian Elephant.***Fasciola hepatica*, p. 29..... Liver.**248. Equus caballus. Horse.**☐ *Fasciola hepatica*, p. 29..... Liver.*Coenurus cerebralis*, p. 109..... Cerebrum.☐ *Echinococcus polymorphus*, p. 113..... Liver.**246. Equus asinus. Ass.***Dicrocoelium lanceatum*, p. 55..... Liver.☐ *Fasciola hepatica*, p. 29..... Liver.☐ *Echinococcus polymorphus*, p. 113..... Liver.**215. Bos bubalis. Indian Buffalo.***Amphistoma cerri*, p. 64..... Rumén.☐ *Fasciola hepatica aegyptiaca*, p. 48..... Liver.☐ *Gastrothylax gregarius*, p. 67..... Rumén.**217b. Bos frontalis. Gayal.***Gastrothylax Cobboldii*, p. 67..... Rumén.*Gastrothylax elongatum*, p. 67..... Rumén.*Homalogaster Paloniae*, p. 67..... Caecum.**Bos indicus. Zebu. (See also p. 67).***Moniezia expansa*, p. 128..... Intestine.

216. *Bos taurus*. Domesticated cattle.

☐ <i>Amphistoma cervi</i> , p. 64.....	Rumen.
<i>Amphistoma explanatum</i> , p. 67.....	Gall bladder.
<i>Amphistoma tuberculatum</i> , p. 67.....	Rumen.
☐ <i>Dicrocoelium lanceatum</i> , p. 55.....	Liver.
<i>Dicrocoelium pancreaticum</i> , p. 57.....	Pancreas.
† <i>Fasciola gigantica</i> , p. 49.....	Liver.
⊕ <i>Fasciola hepatica</i> , p. 29.....	Liver and lungs.
☐ <i>Fasciola hepatica angusta</i> , p. 48.....	Liver.
☐ <i>Fasciola hepatica aegyptiaca</i> , p. 48.....	Liver.
⊕ <i>Fasciola magna</i> , p. 49.....	Liver and lungs.
<i>Gastrothylax crumenifer</i> , p. 67.....	Rumen.
<i>Homalogaster Poirieri</i> , p. 67.....	Large intestine.
☐ <i>Schistosoma bovis</i> , p. 60.....	Veins.
† <i>Schistosoma haematobium</i> , p. 58.....	Veins.
<i>Coenurus cerebralis</i> , p. 109.....	Brain.
⊕ <i>Cysticercus bovis</i> , p. 71.....	Muscle.
⊕ <i>Cysticercus tenuicollis</i> , p. 96.....	Liver and mesentery.
⊕ <i>Echinococcus polymorphus</i> , p. 113.....	Liver and lungs.
☐ <i>Moniezia alba</i> , p. 127.....	Intestine.
☐ <i>Moniezia Benedeni</i> , p. 128.....	Intestine.
⊕ <i>Moniezia expansa</i> , p. 128.....	Intestine.
⊕ <i>Moniezia planissima</i> , p. 127.....	Intestine.
† <i>Stilesia centripunctata</i> , p. 130.....	Intestine.
† <i>Stilesia globipunctata</i> , p. 130.....	Intestine.
† <i>Thysanosoma Giardi</i> , p. 129.....	Intestine.

218. *Ovibos moschatus*. Musk Ox.

<i>Moniezia expansa</i> , p. 128.....	Intestine.
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Ovis ammon.

<i>Echinococcus polymorphus</i> , p. 113.	
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219. *Ovis argali*. Argali.

<i>Fasciola hepatica</i> , p. 29.....	Liver.
<i>Cysticercus tenuicollis</i> , p. 96.....	Liver and mesentery.
<i>Echinococcus polymorphus</i> , p. 113.....	Liver and lungs.

220. *Ovis aries*. Domesticated sheep.

⊕ <i>Amphistoma cervi</i> , p. 64.....	Rumen.
☐ <i>Dicrocoelium lanceatum</i> , p. 55.....	Liver.
⊕ <i>Fasciola hepatica</i> , p. 29.....	Liver.
<i>Dicrocoelium pancreaticum</i> , p. 57.....	
<i>Schistosoma bovis</i> , p. 60.....	Veins.
☐ <i>Coenurus cerebralis</i> , p. 109.....	Brain and spinal cord.
⊕ <i>Cysticercus tenuicollis</i> , p. 96.....	Mesentery.
☐ <i>Echinococcus polymorphus</i> , p. 113.....	Liver and lungs.
<i>Moniezia alba</i> , p. 127.....	Intestine.
☐ <i>Moniezia Benedeni</i> , p. 128.....	Intestine.
⊕ <i>Moniezia expansa</i> , p. 128.....	Intestine.
⊕ <i>Moniezia Neumannii</i> , p. 128.....	Intestine.
† ☐ <i>Moniezia nullicollis</i> , p. 26.....	Intestine.
⊕ <i>Moniezia planissima</i> , p. 127.....	Intestine.
⊕ <i>Moniezia trigonophora</i> , p. 128.....	Intestine.
☐ <i>Moniezia Vogti</i> , p. 127.....	Intestine.
☐ <i>Stilesia centripunctata</i> , p. 130.....	Intestine.
☐ <i>Stilesia globipunctata</i> , p. 130.....	Intestine.
⊕ <i>Thysanosoma actinioides</i> , p. 128.....	Gall ducts and intestine.
☐ <i>Thysanosoma Giardi</i> , p. 129.....	Intestine.

220. *Ovis laticauda*.
 □ *Moniezia expansa*, p. 128..... Intestine
221. *Ovis musimon*. Mufflon.
 Coenurus cerebralis, p. 109..... Cerebrum.
 Cysticercus tenuicollis, p. 96..... Liver and mesentery.
222. *Capra hircus*. Goat.
 Amphistoma cervi, p. 64..... Rumens.
 Dicrocoelium lanceatum, p. 55..... Liver.
 Fasciola hepatica, p. 29..... Liver.
 Coenurus cerebralis, p. 109..... Brain.
 ⊕ *Cysticercus tenuicollis*, p. 96..... Mesentery.
 Echinococcus polymorphus, p. 113..... Liver and lungs.
 Moniezia expansa, p. 128..... Intestine.
 ! □ *Moniezia caprae*..... Intestine.
- Capra pyrenaica*. Spanish Ibex.
 Moniezia expansa, p. 128..... Intestine.
225. *Rupicapra tragus*. Chamois or Gemse.
 Cysticercus tenuicollis, p. 96..... Liver and mesentery.
 Moniezia expansa, p. 128..... Intestine.
- Boselaphus tragocamelus*. Nilgai or Blue Bull.
 Fasciola hepatica, p. 29..... Liver.
 Fasciola magna, p. 49..... Liver.
- Hippotragus equinus*. Roan Antelope.
 Coenurus cerebralis, p. 109.
- Oryx beisa*. Beisa.
 Cysticercus tenuicollis, p. 96.
224. *Oryx leucoryx*. Leucoryx.
 Cysticercus tenuicollis, p. 96..... Liver and mesentery.
226. *Saiga tartarica*. Saiga.
 Cysticercus tenuicollis, p. 96..... Liver and mesentery.
223. *Gazella dorcas*. Dorcas Gazelle.
 Amphistoma cervi, p. 64..... Rumens.
 Dicrocoelium lanceatum, p. 55..... Liver.
 Fasciola hepatica, p. 29..... Liver.
 Cysticercus tenuicollis, p. 96..... Mesentery.
 Moniezia expansa, p. 128..... Intestine.
227. *Gazella euchore*. Springbok.
 Cysticercus tenuicollis, p. 96..... Liver and mesentery.
227. Antelope euchore. (See *Gazella euchore*.)
224. Antelope leucoryx. (See *Oryx leucoryx*.)
226. Antelope saiga. (See *Saiga tartarica*.)
- Kobus ellipsiprymus*. Waterbuck.
 Cysticercus tenuicollis, p. 96.
- Antilocapra americana*.
 ⊕ *Cysticercus boris*, p. 71..... Muscles.
241. *Giraffa camelopardalis*. Giraffe.
 Fasciola gigantica, p. 49..... Liver.
 Cysticercus boris, p. 71..... Muscles.
 Echinococcus polymorphus, p. 113..... Liver.
240. *Cariacus americanus*. Virginia Deer.
 Fasciola hepatica, p. 29..... Liver.
 ⊕ *Fasciola magna*, p. 49..... Liver.
232. *Cariacus campestris*.
 Amphistoma cervi, p. 64..... Rumens.
 Moniezia expansa, p. 128..... Intestine.

237. **Cariacus nambi.**
Amphistoma cervi, p. 64..... Rumens.
Moniezia expansa, p. 128..... Intestine.
Thysanosoma actinioides, p. 128..... Intestine.
233. **Cariacus paludosus.**
Amphistoma cervi, p. 64..... Rumens.
Thysanosoma actinioides, p. 128..... Intestine.
238. **Cariacus rufus. Brocket.**
Amphistoma cervi, p. 64..... Rumens.
Cysticercus tenuicollis, p. 96..... *Liver and mesentery.
Moniezia expansa, p. 128..... Intestine.
Thysanosoma actinioides, p. 128..... Intestine.
238. **Mazama rufus. (See Cariacus rufus.)**
Cariacus simplicicornis.
Amphistoma cervi, p. 64..... Rumens.
Cysticercus tenuicollis, p. 96..... Liver and mesentery.
Thysanosoma actinioides, p. 128..... Intestine.
240. **Cariacus virginianus. (See Cariacus americanus.)**
234. **Capreolus caprea. Roe Deer.**
Amphistoma cervi, p. 64..... Rumens.
Fasciola hepatica, p. 29..... Liver.
Coenurus cerebralis, p. 109..... Brain.
Cysticercus cellulosae, p. 89..... Liver and mesentery.
Cysticercus tenuicollis, p. 96.....
Moniezia expansa, p. 128..... Intestine.
Taenia crucigera..... Intestine.
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230. **Alce alces. European Elk.**
Amphistoma cervi, p. 64..... Rumens.
Echinococcus polymorphus, p. 113.....
230. **Alces machlis. (See Alce alces.)**
230. **Alces palmatus. (See Alce alces.)**
239. **Tarandus rangifer. Reindeer or Caribou.**
Coenurus cerebralis, p. 109..... Brain.
Cysticercus tenuicollis, p. 96..... Liver and mesentery.
230. **Cervus alces. (See Alce alces.)**
231. **Cervus axis. Axis deer.**
Cysticercus tenuicollis, p. 96..... Liver and mesentery.
- Cervus canadensis. Elk or Wapiti.**
Fasciola magna, p. 49..... Liver.
235. **Cervus dama. Fallow Deer.**
Amphistoma cervi, p. 64..... Rumens.
Dicrocoelium lanceatum, p. 55..... Liver.
Fasciola hepatica, p. 29..... Liver.
Fasciola magna, p. 49..... Liver.
236. **Cervus elaphus. Stag.**
Amphistoma cervi, p. 64..... Rumens.
Dicrocoelium lanceatum, p. 55..... Liver.
Fasciola hepatica, p. 29..... Liver.
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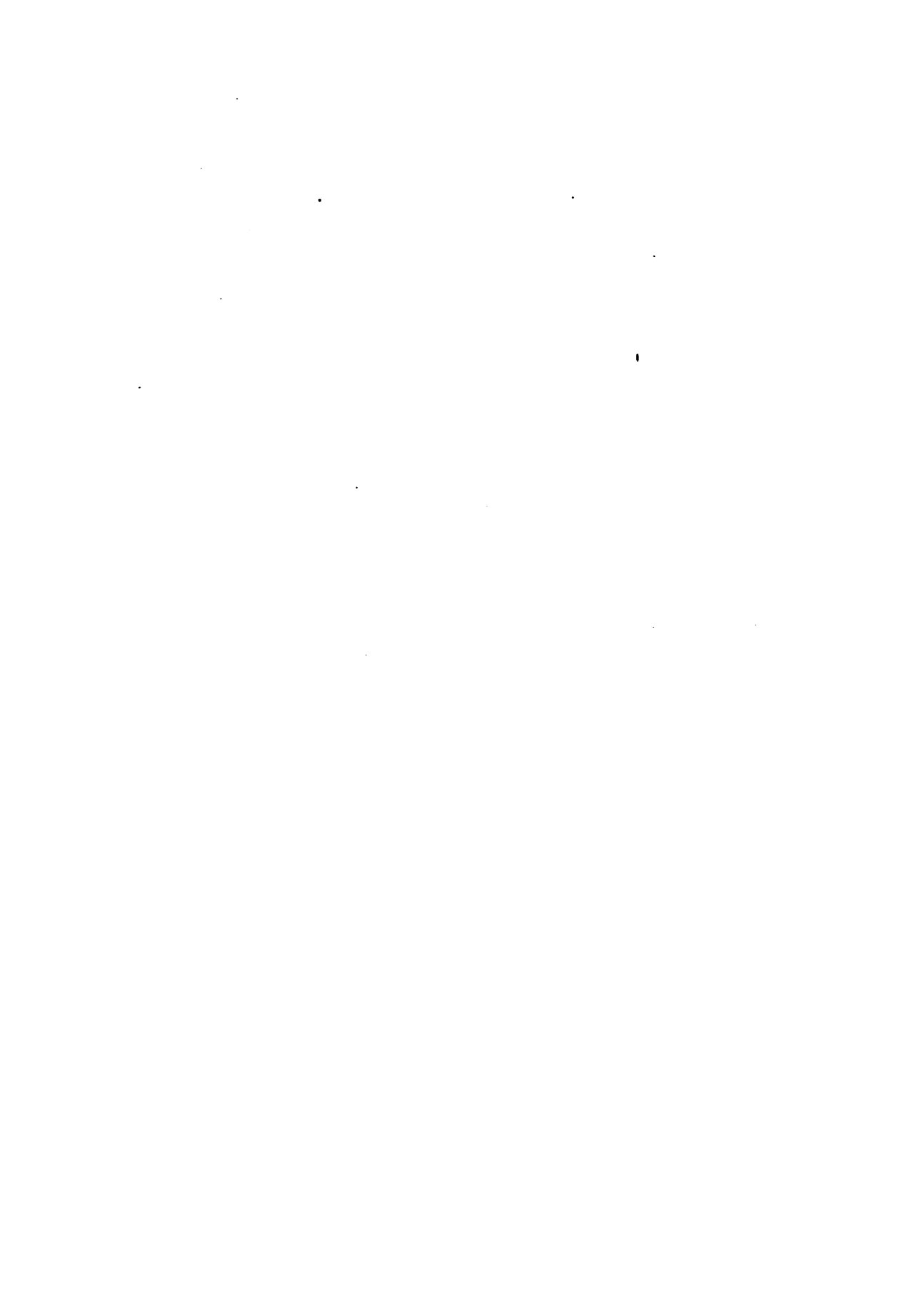
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BULLETIN No. 20.

(Dairy No. 19.)

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.

THE MILK SUPPLY OF BOSTON
AND OTHER NEW ENGLAND CITIES.

BY

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Under the direction of
Dr. D. E. SALMON,
Chief of the Bureau of Animal Industry.



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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., January 18, 1898.

SIR: I have the honor to transmit herewith, for publication as a bulletin of this Bureau, a report on the milk supply of Boston and other cities in the New England States, prepared under the immediate supervision of Maj. Henry E. Alvord, Chief of Dairy Division, by George M. Whitaker, M. A., special agent of that division.

Mr. Whitaker is the acting executive officer of the Massachusetts State Dairy Bureau, and has been for some years secretary of the New England Milk Producers' Union. He has made the subject of city milk supply a special study, and this report contains much information of general interest.

Very respectfully,

D. E. SALMON,
Chief of Bureau of Animal Industry.

HON. JAMES WILSON,
Secretary of Agriculture.



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THE MILK SUPPLY OF BOSTON AND OTHER NEW ENGLAND CITIES.

POPULATION.

The New England States, by the census of 1890, have a population of nearly 5,000,000 people, divided as follows:

Massachusetts	2, 238, 943
Connecticut	746, 258
Maine	661, 086
New Hampshire.....	376, 530
Rhode Island	345, 506
Vermont.....	332, 422
Total.....	4, 700, 745

Massachusetts, by the State census of 1895, has a population of 2,500,183. Fifty per cent of these people live in the cities or large towns—those of 10,000 population or above. Forty-one per cent of the population of New England live in cities of over 20,000 inhabitants. Boston is the largest city and the commercial center of New England, with a population of 496,920 (census of 1895). This one city therefore contains 10 per cent of all the population of New England; more than any one of the States of Rhode Island, New Hampshire, or Vermont. But Boston is surrounded by a group of towns and cities, twenty-three in all, which, according to the State census of 1895, have a total population of 451,000, as follows:

Cambridge	81, 000	Medford.....	14, 000
Lynn	62, 000	Hyde Park	11, 000
Somerville	52, 000	Melrose	12, 000
Chelsea	31, 000	Stoneham	6, 000
Newton	27, 000	Arlington	6, 000
Malden	29, 000	Belmont.....	3, 000
Waltham.....	20, 000	Saugus.....	4, 000
Quincy.....	20, 000	Winchester	6, 000
Woburn.....	14, 000	Watertown.....	7, 000
Brookline	16, 000	Revere	7, 000
Everett.....	18, 000	Milton	5, 000

The interests of these towns are closely allied with those of Boston, and their business men to a large extent do business in Boston. The business interests of this section are identical, though it includes twenty-four separate municipalities. Consequently it is frequently

alluded to as the "Greater Boston." The Greater Boston has a population which exceeds 948,000. This is 18 per cent of the population of New England—more than any New England State except Massachusetts, and more than any two of the three smaller States.

Providence is the second New England city, with a population exceeding 150,000.

Aside from the Greater Boston and Providence, no New England city, by the census of 1890, had a population exceeding 100,000. The following five cities, with a total of 374,000 persons, each had a population exceeding 50,000, but less than 100,000:

	Census of 1890.	State census of 1895.
New Haven, Conn.	85,000	.....
Worcester, Mass.	84,000	98,000
Lowell, Mass.	77,000	84,000
Fall River, Mass.	74,000	89,000
Hartford, Conn.	53,000	.....

The following nineteen cities (total, 534,000) had a population between 20,000 and 50,000, and thirty-six others had a population of from 10,000 to 20,000 each:

	Census of 1890.	State census of 1895.		Census of 1890.	State census of 1895.
Bridgeport, Conn.	49,000	.....	Brockton, Mass.	27,000	38,000
Manchester, N. H.	44,000	.....	Haverhill, Mass.	27,000	30,000
Lawrence, Mass.	44,000	52,000	Taunton, Mass.	25,000	27,000
Springfield, Mass.	44,000	51,000	Lewiston, Me.	22,000	.....
New Bedford, Mass.	41,000	55,000	Fitchburg, Mass.	22,000	26,000
Portland, Me.	36,000	.....	Woonsocket, R. I.	21,000	.....
Holyoke, Mass.	35,000	40,000	Glooucester, Mass.	21,000	28,000
Salem, Mass.	30,000	34,000	Merriden, Conn.	21,000	.....
Waterbury, Conn.	28,000	.....	Lincoln, R. I.	20,000	.....
Pawtucket, R. I.	27,000	.....			

A study of the milk supply of these cities, therefore, is a study of the milk supply of half of the population of New England. Furthermore, a consideration of the milk supply of New England must, to a considerable extent, be devoted to the milk supply of the Greater Boston, which has 18 per cent of all the population of New England and over one-third of the city population of that section, the remainder being distributed among sixty-four places.

It is proper that Boston should receive almost a monopoly of attention for another reason than that of its relative size and commercial importance. It is about the only city in New England whose supply presents interesting and peculiar conditions.

Nearly all of the milk supply of the other cities and large towns comes from sources within a dozen miles of the point of consumption, and is largely distributed by producers from their own wagons. The ordinary milk peddler is such a familiar spectacle, so similar to every other peddler, as to make a detailed report of his work in the different

cities an uninteresting repetition of substantially the same methods, conditions, and circumstances which are already well known. On the other hand, most of the Greater Boston supply coming from more remote distances by railroads, presents conditions peculiar to itself.

MILK SUPPLY—TRANSPORTATION, DISTRIBUTION, STATISTICS.

BOSTON.

Cars.—Three-fourths of the milk supply of the Greater Boston reaches the city by railroad. The longest direct run is 140 miles, and some railroad milk comes only 20 miles. Most of this milk is conveyed in cars built for this especial purpose, with refrigerator closets for the cans of milk and with provision for steam heat. Thus refrigeration in summer and warming in winter are provided. Some of the cars have an office room provided with chairs, desk, and pigeonholes for the use of the man in charge of the car. Here he has all needed conveniences for keeping record of the milk taken at the different stations, and other necessary accounts.

These cars are leased from the railroads by wholesalers. These wholesalers furnish the carmen, ice, and other supplies; the railroad hauls the cars on passenger trains or in special milk trains, according to convenience in individual cases. Most of the cars start in the morning, from 4 to 6 o'clock, and reach the city between 10 and 11. In a few instances the car starts the afternoon previous, and is on the road over night, reaching Boston during the next forenoon. The cars, in the summer, frequently take the milk of the same morning; some start too early for the milk of that morning, especially in the winter, and hence bring the milk of the previous day. Milk is therefore eighteen to thirty hours old before reaching the city. The number of these milk cars averages about 35, although varying somewhat with the season.

Cans.—The milk sold in Boston is shipped in 8½-quart cans, with a handle on one side and turned wooden stopples. The quart is, by statute, the wine measure quart.¹ No one in the trade to-day can tell why this size and shape of cans was originally adopted. The advantages claimed for them are: Convenience in handling, convenience in retailing (as many customers buy one or two cans), convenience to many small farmers who can fill only two or three cans per day, convenience in transportation (as the cans can be stacked several tiers high), cleanliness in retailing where milk is poured from the can, as it is sooner emptied than a 40-quart can, and hence the milk is exposed to the air and dirt a much less time.²

¹One quart, wine measure, is 57½ cubic inches, or 2 pounds 1½ ounces of water, and 2 pounds 2½ ounces of milk.

²On the other hand, there are serious objections to the Boston can. Five small cans cost more than one large one and are more difficult and expensive to clean. The danger of loss and damage is increased. But the worst thing about it is the wooden stopple. Milk enters the pores of the wood and penetrates so far that no

For several years in the early history of the business there was in use a can containing $8\frac{1}{2}$ quarts beer measure,¹ equal to about 10 quarts wine measure; but it gradually dropped out of use, the smaller can being more popular. The larger can is yet in use in Providence, R. I., but the $8\frac{1}{2}$ -quart can, wine measure, is generally used throughout New England. The business was formerly done by beer measure, and these $8\frac{1}{2}$ -quart cans, wine measure, hold 7 quarts, beer measure. The agitation for the change was partly based on the expectation that there would be more money for farmers and middlemen by getting $8\frac{1}{2}$ quarts into a can that had formerly contained 7 quarts. But consumers were not slow to discover that they were getting a smaller quart, and the attempt failed to gain the price of $1\frac{1}{2}$ quarts per can by the flat that the quart should be smaller.

A carload of milk is generally considered to be 900 cans, but the peculiar shape, with flat-top wooden stopples, allows of stacking them in tiers, so that in an emergency several hundred more cans can be put into a car. By filling passageways and other open spaces as many as 1,200 cans (10,200 quarts), or over 10 tons in weight, can be got into a car. Railroad officials consider 10 tons a carload. The nominal load, however, is 900 cans (7,650 quarts).

The accompanying illustrations (Plates II, III) show the general shape of the cans and illustrate the method of handling them. These engravings present a familiar daily sight at the milk depots when the milk trains arrive.

Historical.—Boston seems to have been the pioneer city of the United States in the transportation of milk by railroad. The year 1830 may be taken as the commencement in the United States of the railroad system—the use of steam applied to locomotives. Soon after this we find the Boston peddlers reaching out into the country for a milk supply. Jason Chamberlain was the first man to bring milk to Boston by railroad, and the time of his beginning was April, 1838. He operated on the Boston and Worcester Railroad. He sold milk at 25 cents per can of $9\frac{1}{2}$ quarts. Mr. Chamberlain sold his business to Rufus Whiting, who is said to have been the first to start an express business on the Boston and Worcester Railroad. He was an associate with, and sold his business to, Mr. Harnden, the now famous express promoter. This milk came by express, but in a baggage car. The first milk car was run soon after, by a company of peddlers, between Westboro and Boston. This was followed by the Boston Milk Company,

cleaning process is efficient. Stopples split have shown penetration for half an inch, commonly, and sometimes more, and from these pieces germ cultures have been made of an extremely objectionable and offensive kind, although the stopples had been soaked, scalded, and steamed, and were supposed to be clean and harmless.

H. E. A.

¹ One quart, beer measure, is 704 cubic inches, or 2 pounds 8½ ounces of water, and 2 pounds 10 ounces of milk.



FIG. 1.—MILK TRAIN AT CITY TERMINAL, BOSTON.



FIG. 2.—INTERIOR OF MILK-RECEIVING SHEDS, CITY TERMINAL.





FIG. 1.—MILK DEPOT OF BOSTON CONTRACTOR.



FIG. 2.—INTERIOR OF MILK-CONTRACTOR'S DEPOT, BOSTON.



which ran a car to Cordaville, and by Rowell & Kelly, who took milk from Northboro and Fayville. In April, 1843, the New England Farmer said:

We have learned that one man brings in upon the Worcester Railroad about 200,000 gallons annually. This is supposed to be about one-tenth of all that is sold in the city. Two millions of gallons per year is the estimated amount of consumption in Boston. This, at 20 cents per gallon, costs the citizens \$400,000 per year, and, supposing the population to be 100,000, this gives to each inhabitant yearly 20 gallons, or a small fraction less than half a pint per day. The dwellers in the city of "notions" have a notion that they pay the farmers a good price for milk. Five or 6 cents per quart is usually given. This pays the farmers of the immediate vicinity as well as they get paid for most of their productions. But can those farmers live who sell milk at their doors at 10 cents per gallon in the summer and 12 cents in the winter, or at an average of 11 cents? Many such farmers there are, and some sell at lower rates than this, and yet the milk dealer gets no more than a fair compensation for his labors, expenses, and risks.

An article from the Albany Cultivator, reprinted in the New England Farmer September 6, 1843, said:

A brighter day is dawning on the dwellers in cities so far as milk is concerned, and the venders of swill slop, cold water, and artificial milks are finding their business seriously endangered. This is being brought about by the influence of railroads, which, spreading a network over the country and centering in the cities, bring the farmers and dairymen residing within 50 miles of the city within a few hours, and enable them to offer their products in the best possible condition for competition. This effect was first extensively felt in Boston in the reduction of the price and the bettering of the quality of milk, though that city had never been forced to use such scandalous stuff as was sold in other places for milk. At the present time a large portion of the milk used in that city is received by the railroads from country dairymen. The same beneficial effects are beginning to be felt in New York.

At one time two cars were loaded daily at Westboro, some farmers driving 15 miles daily to the railroad station with their supplies. Although milk consumption has increased and the milk territory has extended wonderfully since then, the shipments from this station have decreased. The growth of neighboring towns has caused more milk to be used near where it is produced.

The railroad business above noticed developed on the Boston and Worcester Railroad, entering the city on the south side. Meanwhile, however, similar enterprises had been undertaken on the north side of the city. Peddlers had gone out to Concord, Mass., and other places for milk and supplies.

T. W. Wellington, of Newton, was the first to buy milk in Wilton, N. H., for the Boston market. For about a year Mr. Wellington continued in the business, taking less than 200 gallons per day in a baggage car. Mr. Wellington sold to David L. Pierce, a retail milk dealer in Boston, who increased the business so that a special milk car was necessary. After continuing in the business for three or four years he sold to David Whiting, in the spring of 1857.

Present wholesale methods.—These early shipments of milk were made

by peddlers who brought into the city the milk which they needed for their retail trade. But as the business increased there happened what has taken place in every other industry—specialization. Handling milk at wholesale became a distinct business from retailing, and the men who brought in railroad milk came in time to devote the whole of their energy and capital to buying milk of the farmers, transporting it, and selling to retailers.

Various changes have taken place in the personnel of these firms of pioneer peddlers and subsequent wholesalers, but many of the names early identified with the business are still in use. Consolidations have also taken place, till to-day the business of transporting milk to the city by railroad is done by seven concerns. Six of these seven milk wholesaling houses have an association for bringing about uniformity in methods of doing business and for mutual self-protection. To-day fully three-quarters of the milk supply of the Greater Boston passes through the hands of these large wholesalers, locally known as "contractors."

These contractors furnish the cans for the business and lease the cars of the railroads. They furnish men and supplies for the cars. In some cases they have loading platforms at shipping stations. At a number of convenient points in the country they have ice houses and cut their own supply of ice. In the city they have platforms, storehouses, refrigerators, offices, etc., near the railroad tracks; and their cars on reaching the city are switched onto the side tracks at their business depots. The loading and unloading is done by the contractors.

All of the contractors have cheese or butter factories in the city or country, or both, for the manufacture of butter and cheese.

The milk is bought in the country at a price for the milk delivered at the car at the different country railroad stations. In some instances each farmer carries his milk to the railroad station; in others the farmers in one neighborhood or in one locality cooperate in an arrangement with one of their number to do the teaming; in yet other instances the contractors employ someone to haul milk from the farmers' doors to the railroad station, and deduct the expense from the amount due the farmers for milk. Milk is frequently drawn 6 miles to a railroad station, and in some cases as far as 10 to 15 miles.

The wholesalers or contractors.—The various companies and individuals above alluded to as carrying milk on the Boston and Worcester Railroad, on the south side of the city, consolidated into the firm of C. Brigham & Co. to do a strictly wholesale business. This company later became incorporated as The C. Brigham Company, and is yet in the business.

Mr. David Whiting, who bought the business of Mr. Wellington, as noticed above, was a large and successful farmer. Although driven into the business to protect his interests, the traits of character which brought success in other enterprises made him successful as a milk wholesaler. In 1865 he associated with him his sons, George O. and

Harvey A., under the firm name of D. Whiting & Sons. The business is continued to-day under the same name, two of Mr. Whiting's grandsons being among the executive officers.

Mr. H. P. Hood began in the milk business in Boston, as a peddler, in 1846. For nine years he bought milk of contractors, but in 1855 he began running a car on his own account from Derry, N. H., to which place he moved. He has been in the wholesale milk business ever since, and has increased the business from one to eight cars. His sons are now associated with him in the management of the business.

The Boston Dairy Company is the newest of the larger companies; it is the consolidation of several interests, and is a continuation of the long-established business of Tower & Whitcomb. Mr. W. A. Graustein is the executive head.

The Elm Farm Company was started by a wealthy farmer-manufacturer, Mr. Ray, of Franklin, Mass., as a means of marketing his own milk independent of the regular contractors; but he soon commenced buying milk of his farmer neighbors, and the business extended until the company confined itself to a wholesale business.

Mr. J. F. French brings one carload per day into the city, and has done so for several years.

These are the component elements of the contractors' association.

In addition, one car of milk per day is brought into the city by the Deerfoot Farm Company of Southboro, Mass., much of which is sold direct by themselves to the consumers. The Deerfoot Farm Company was started by Hon. Edward Burnett to furnish high-grade Jersey milk to patrons able and willing to pay a corresponding price, but latterly the business has increased so as to include, in addition to the above, a general wholesale trade. Mr. Robert Burnett is the executive manager.

Mr. George O. Whiting, the executive head of D. Whiting & Sons, owns a controlling interest in the C. Brigham Company and in the Elm Farm Company. He is a man of much executive energy, and is known as "the milk king of New England."

Statistics.—The members of the Milk Contractors' Association report monthly to each other their receipts and sales, and have done so for years, so that much valuable information has accumulated in connection with the business. These figures are not absolutely infallible for purposes of comparison, because the association has occasionally taken in new members, whose receipts and sales are then added to those of the others. But those persons to whom such statistics are serviceable can make some allowance for this and find much value in the figures.

We give below some recent tables on this subject, the figures representing the number of $8\frac{1}{2}$ -quart cans:

Year.	Receipts.	Sales.	Surplus.
1892	9,212,667	7,315,135	.....
1893	9,263,487	7,619,722	1,643,765
1894	9,705,447	7,657,421	2,048,026
1895	9,856,500	8,040,732	1,815,768
1896.			
January	844,799	651,827	192,882
February	808,383	611,793	196,590
March	871,572	667,039	214,534
April	891,275	672,561	218,714
May	1,005,115	695,599	308,516
June	994,817	675,796	319,021
July	899,397	712,188	187,209
August	854,913	687,224	167,689
September	886,691	635,092	251,599
October	960,734	669,245	291,489
November	885,903	680,920	194,983
December	898,599	707,065	191,534
Total	10,782,108	8,097,379	2,684,729
1897.			
January	923,852	705,324	218,528
February	835,115	639,952	195,163
March	960,084	719,814	240,270
April	976,996	733,298	243,698
May	1,105,325	759,875	345,450
June	1,115,234	752,038	363,196
July	1,013,552	789,849	223,703
August	966,058	720,374	245,684
September	956,445	732,795	223,650
October	1,037,764	751,944	285,820
November	962,552	708,459	254,093
December	945,254	724,850	220,364
Total	11,798,231	8,738,572	3,059,619

Milk Producers' Union.—Before going on to speak further about the prices of milk and some of the detailed methods of handling it which are peculiar to Boston, a word should be spoken about the Milk Producers' Union. This is an organization of the farmers who sell milk to the contractors. The farmers of the several shipping towns form a local organization and send delegates to an annual meeting of the central union, which elects executive officers and transacts other necessary business. The organization has been in existence in one form or another since 1886. The work of the union, which has been supplemented by that of the association of wholesalers, who regulate the business from their end, has been to promote uniformity and business-like methods. The tabulation and publication of the above statistics were brought about through the combined efforts of the Milk Producers' Union and the Milk Contractors' Association. The prices of milk are usually arranged by mutual agreement between the contractors and the officers of the Milk Producers' Union. Blanks are sent semi-annually to the producers belonging to the union, on which they express their opinion as to the price of milk and state the number of cans shipped. These replies are averaged on the basis of cans rather

ber, 1896, the winter price was cut again, leaving the difference only 2 cents. The increasing attention given to winter dairying has brought the supply of winter milk nearer to that of summer milk, and made advisable, so the contractors claim, less disparity in price.

The increase of winter dairying has been caused not only by the increased profit in winter milk, but to a certain extent, in market gardening sections, by the desire of farmers who produce milk to carry more cows in the winter in order to get manure for their garden crops.

Payments to the farmers for milk sold to the contractors are made monthly, as soon after the 1st of the month as the clerical work of closing the accounts and drawing checks can be done.

According to the agreement alluded to, the payment per can of milk which the farmer would receive at his railroad station would be the theoretical Boston price less 8, 9, 10, or 11 cents, depending upon his distance from the city. The amount of milk handled by the contractors is so large that these prices govern to a considerable extent the dealings of many milkmen in other places.

When this arrangement was first considered, it was expected that the theoretical Boston price would be the figure at which milk would be sold to the peddlers, and that the discount would therefore represent cost of transportation, cost of doing the business, losses from bad bills, and profits; but competition of one kind and another has reduced the price to the peddlers so that they now pay 3 and 4 cents less than the nominal Boston price, and it has become wholly a theoretical figure, used and useful only as a number from which to subtract the various discounts depending upon distance of transportation. The expenses of doing the business and the profits to the contractors are therefore from 4 to 7 cents per can.

Milk was sold by the contractors to peddlers during the summer of 1897 at 30 cents per can, with rumors of cutting prices to 29 and even 28 cents. Milk is sold by the peddlers at varying prices. Hotels and large restaurants buy close and allow only 2 or 3 cents for handling; they bought during 1897 at 32 to 35 cents per can. Small stores, which retail by the quart the contents of only a few cans, pay 38 to 40 cents per can. Consumers of a can daily pay 45 and 50 cents, and those who have a quart of milk delivered at their houses daily by the milkman pay 7 cents per quart. Sometimes pint customers pay at the rate of 8 cents per quart. By going to the store for it, consumers frequently buy as low as 6 cents, and in some instances for 5. Milk in a few cases seems to be selected by grocers and provision dealers as an article to sell at cost or a little less as a bid for other business.

Grading the price.—One of the peculiarities of the way in which the Boston milk business is carried on by the contractors is what is called "grading the price." To illustrate: The contractors agree to pay at stations situated a certain distance from Boston 24 cents per can for the summer—that is, from April to October. But they do not pay 24

cents for each and every month; instead of that, they pay a price which will average 24 cents. During the flush months of May and June the price may be perhaps 22 cents, and to offset that cut the price will be increased to 26 cents during the sultry months of August and September, when milk is sometimes scarce. This "grading" has a tendency to discourage exceptionally large shipments during months when the supply would naturally be the largest. It also stimulates production during the months when the supply might otherwise be short. When the price has been agreed upon, the contractors send to each station a card similar to the following:

(For railroad stations in the towns of Chelmsford and Sudbury, summer of 1897.)

The graded price of milk per can of eight and one-half quarts, delivered in good order, with dairy number plainly marked on stopper with stickers, and up to the standard required by law, in the car, for the following six months, from April 1, 1897, will be:

	Cents.		Cents.
April	24	July	24
May	22	August	26
June	22	September	26
Average, 24 cents.			

In case the amount of milk received by the contractors and not sold for use as milk shall exceed 5 per cent of the entire sales of the month, then for said excess over and above the 5 per cent the contractors shall pay only what said excess is worth for butter, taking the average price of butter for the month; and the value of the surplus milk, manufactured into butter, shall be determined by a committee of farmers and contractors.

MILK CANS.

Milk cans are the property of the persons or company whose name is stamped upon them. The ownership is absolute. The legislature has passed a law which makes it a criminal offense, punishable by fine and imprisonment, to retain or make use of a milk can for any purpose whatever without the consent of the contractor or owner. (See chapter 440, Acts of 1893.)

Contractors' surplus milk.—As stated above, the contractors and the Producers' Union agree upon a price for six months in advance. In doing this the purchasing contractors seem to be taking some chances, for they can not foresee the demand. Particularly is this the case in the summer, for then the demand depends much on the weather, as a hot, sultry "spell" causes the consumption of milk to increase rapidly. Further than this, the contractors appear to take large chances in another way. They agree to take all the milk that the farmers supplying them with milk at the various shipping stations may produce. This leads to receipts largely in excess of the demand, as has been seen by the preceding tables of receipts and sales; the excess sometimes reaches one-fourth of the receipts. The contractors save themselves from loss by an arrangement by which the stipulated price is paid for only such milk as is sold again and for a small margin in excess (equal to 5 per cent of the sales; see above card). All surplus beyond this is made into butter by the contractors, at their creameries, on the farmers'

account, allowing each month, as the value of the butter, the average of the jobbing price of butter quoted by the chamber of commerce during the month and charging 4 cents per pound for making. Thus the farmer is sure of getting at least butter value for all the milk he can make. To protect the farmers from an undue extension of this surplus privilege, the contractors agree not to extend their routes or enlarge their territory. The advantages of this surplus system are:

(1) The market is more steady than it would otherwise be. The figures above show that the price has been very uniform for many years. The surplus, being in the hands of the large dealers, does not get upon the market, and the supply offered to the retail trade by the contractors is never in excess of the demand.

(2) The contractors have a large reservoir to draw from when sultry summer weather or other cause increases the demand; hence the market is never short of milk.

(3) The farmers find a market for more milk than they otherwise would, though the surplus portion is sold at much less than the other part. The butter value of the surplus milk for the year 1896, less the cost of making, was 13 cents per can, a fraction over 71 cents per hundred pounds. For 1897 the butter value of a can of milk averaged 13½ cents, a little better than for 1896.

The disadvantage of the system is that it is the cause of much friction between the producers and the contractors. The surplus offers a good opportunity to increase the farmers' natural suspicion of the contractors. The application of the system is blind to many farmers, some of whom even question the honesty of the contractors in accounting for the amount of the surplus. This difference is further intensified by the method of settling with the farmers. The contractors, for their convenience, ascertain how much of a discount the butter value of the surplus would create on the whole amount of milk which a farmer ships, and in making their payment they deduct this amount from what would be due if all milk shipped had been sold at the long price. Hence the monthly bills are not written for the proportionate amount of sale milk at, for instance, 20 cents, plus the proportionate amount of surplus milk at, for instance, 13 cents; but, it having been found that the amount of surplus milk and its butter value is enough to reduce the average price of milk at a 20-cent station 1½ cents, when the farmer makes out his bill for his full shipment at 20 cents per can the contractors discount the bill 1½ cents per can and remit the balance.

The surplus for May, 1897—the butter value of milk being 11 cents per can—amounted to an average discount per can on all shipments as follows:

	Cents.
Where price was 19 cents.	2.26
Where price was 20 cents.	2.54
Where price was 21 cents.	2.82
Where price was 22 cents.	3.11
Where price was 23 cents.	3.39

In this way the contractors' clerks can figure the accounts quite rapidly; but the method increases the dissatisfaction with the system, because to the mind of the farmer the butter value of surplus milk creates an actual discount or a "charge back" on the whole of his bill.

This system of buying all the milk that is offered furnishes shippers a market for all they can produce, but this in turn tends to increase the surplus, which reached unusual proportions during the years 1896 and 1897. This, coupled with the low price of butter, made the discount for those years more than twice what it had previously been. The records of milk meetings and farmers' gatherings show that the surplus is the great cause of dissatisfaction, the burden of many resolutions and speeches being that the contractors should buy "straight." The contractors have sometimes agreed to take all chances of surplus and pay a straight price if they could buy for 2 cents less. Before this system was introduced there was much complaint at the irregularity of the amount sold to the contractors. If the supply ran ahead of the demand, the farmers would receive notice to keep back part of their supplies; and they were liable to be obliged to make butter or cheese in varying quantities every few days. This was a great inconvenience and caused much grumbling, which was remedied by the contractors adopting the present plan, taking all produced and paying butter price for the surplus. But that was so many years ago that the improvement is not generally remembered. The feeling against the surplus was so strong in 1889 that the matter was referred to the State board of arbitration, which decided that the principle was a sound one.

It should be stated here that the different wholesale firms report their receipts, sales, and surplus to their organization and to the Milk-Producers' Union, and the discount is figured on the totals, being the same to all farmers at equal distances from the city, regardless of the contractors to whom they sell or the amount of surplus which their individual wholesaler may have had.

Retailing.—On the arrival of the milk cars in Boston they are run onto the railroad sidings of the milk contractors from 9 to 11 o'clock a. m., regardless of the distance the cars have come. The peddlers by this time have finished their morning's distribution of milk and their wagons are backed to the contractors' platforms and sheds for the next day's supply. The cans are quickly transferred from the cars to the peddlers' wagons. In a few cases, where there are customers for several cans, a delivery is made at once, but most of this milk is carried to the different peddlers' headquarters. Here the milk is run through a large mixer, so as to insure uniform quality. Then it is drawn off into quart and pint cans, of tin, and placed on ice. The next morning about 2 o'clock the peddler starts out to deliver this milk to the customer, leaving at the door of tenement, flat, and dwelling house the can of milk, usually before the family is out of bed. By this it will be seen that the milk is in the city about eighteen hours before reaching the consumer.

It will also be noticed that the milk is delivered in individual cans, never poured or dipped from the large can to the consumer's dish. According to the milk inspector of the municipality of Boston, the number of persons selling milk from wagons during 1896 was 598, and the number of shopkeepers who sold milk was 1,019. In Cambridge there were 189 peddlers and 111 store milk dealers. The numbers remained practically the same in 1897. Nearly all of the peddlers use wagons of the same style—the body like an express wagon, with a rounded canopy top, open at the front and rear.

Clean cans.—When the retailers go to the wholesalers' depots for their daily supplies they usually take with them return cans, belonging to the wholesalers, in which they have taken their supplies on a previous day. These cans are immediately rushed on board the cars, so that the latter may be ready with as little delay as possible to be drawn out and made up in the trains for returning. On account of this procedure the cans are returned to the farmers unwashed, and sometimes in a very filthy condition, for a can may have been delivered by the peddler to a grocer where a portion of the contents which was unsold has soured and stuck to the bottom and sides of the can before the peddler calls for it to return to the wholesaler; in exceptional cases the can may have been used for other articles, possibly kerosene oil. The farmers have frequently consulted together as to the best means of bringing some pressure to bear on the contractors to compel them to return clean cans. This feeling has gone so far as to result in several attempts to induce the legislature to pass compulsory laws on the subject.

The contractors make two excuses for this way of doing business. The first is the matter of expense; they claim that to have the cans washed before returning would mean the impossibility of getting them onto the car that day, and the necessity of having a large investment of money tied up in a triplicate set of cans. The second excuse is that even if they washed the cans, after having been tightly bunged up in the car and on the road for several hours, they would be unfit for use in reshipping milk without being scalded. The contractors claim that if the cans are sent into the country clean many farmers will neglect this precaution, and that the next day's milk would reach the city in worse condition than when the cans are carefully cleaned, scalded, and aired at the dairy before putting fresh milk into them.

Methods of producers and shippers.—The methods pursued by the milk-producing farmers who supply the contractors may be described more in detail, as follows:

For example, a neighborhood may be taken in Windsor or Windham County, Vt., from which the milk is hauled by wagon to Bellows Falls and there put on the milk car.

The process by which the milk is prepared for marketing is simple, though it requires care and attention to preserve an equal temperature.

The morning's milk is cooled by various methods, some employing ice, while not a few suspend the cans in a well. When the night's milk has been cooled, a wood stopper is placed in the full can, upon which is pasted a small adhesive stamp a trifle smaller than a postage stamp, and on this is printed the number of the dairy, as well as the number of the car conveying the milk from Bellows Falls to Boston.

As a rule neighboring dairymen have an arrangement by which one of their number takes the daily product to the main highway, where the cans are picked up every night by the milk wagon and the "empties" returned by the same conveyance in the morning. In some cases, however, the farmer lives 3 or 4 miles off the route, and of course is obliged to bring his own milk.

One route starts from Chester, Windsor County, the distance from the driver's house to Bellows Falls being 16 miles. This driver receives 3 cents per can of $8\frac{1}{2}$ quarts (or $18\frac{1}{4}$ pounds) for carting, and this is, of course, paid by the farmer. With a four-horse covered wagon, this collector starts from his home every night in the week at 9 o'clock, going by the most direct road to Rockingham, thence to Bellows Falls. At present this route furnishes 180 cans, which are picked up in different places along the highway to Bartonville. It takes about six hours to make the trip, which could be done in considerably less time but for the work of picking up the cans. The route is not particularly pleasant by night, and especially is this true in stormy weather, yet for the 365 nights in the year this driver faithfully performs his duty, whether in storm or starlight. The trip is not infrequently attended with disagreeable and even dangerous features, as was the case during the floods of 1897, when the highway was washed out in several places, necessitating a roundabout trip of several miles through Saxtons River. But the milk was delivered every morning at the car before the time of leaving Bellows Falls for Boston.

On arriving at the car the milk is weighed by those in charge and the weights credited to the numbers representing the respective dairymen. The milk car starts daily at 5.30 a. m. and reaches Boston about four hours later, and twenty-eight or twenty-nine hours after the morning milking of the day before. Since the establishment of this route, in the year 1890, the business gradually increased until June, 1897, when the shipments amounted to nearly 700 cans a day.

Boston system summed up.—The advantage of this system of handling milk by large wholesalers, combined into an association, is that the business is in the hands of solvent parties, who can be relied upon to pay the farmers promptly the money due them; the business is done in a uniform, methodical way, all producers being treated alike; there is more publicity to the business than there would be if the milk were sold to a great many small, isolated peddlers. The existing Boston system maintains a more steady market than would otherwise be possible, by keeping off from it an undue surplus which would break the

price; consequently this arrangement insures better prices to farmers than they would otherwise get. Another advantage is in the fact that this large combination of wholesalers doing business in a systematic way, with regular chemists, etc., is a powerful factor in elevating the quality of milk on the market and helping to bring it up to a satisfactory standard. With good laws to start with, to which reference will be made further on, and a strong financial interest working to sustain these laws, a great deal is done for the quality of milk.

There are disadvantages connected with the Boston system, some of which have been sufficiently described. Another is that it does not stimulate any advance in quality of milk beyond meeting the standard required by law.

Other milk supply.—It has already been stated that the milk brought into the city by the contractors is about three-quarters of the whole supply. A portion of the other one-fourth comes in by railroad, brought by peddlers who go into the country and buy direct from the farmers. These peddlers usually buy on the basis of the contractors' prices, for these prices set the pace for about all of the milk business, and, to a large extent, govern it. But these peddlers buy only what their ordinary trade will take. If they occasionally need extra milk they can buy it of the contractors. Though these peddlers pay no more than the regular price, the farmer gets the full price for all that he sells, because the peddler whom he supplies never has a surplus for which to pay a lower price. On the other hand, the more of such business there is the more the surplus tends to increase in the hands of the contractors. Their burdensome surplus is a convenience in a pinch to the outside peddler, who competes with them for milk and for customers, but who carries none of the inconvenience of a surplus.

Another portion of the milk of the Greater Boston is produced within its limits. This is not much of a factor in the city proper, but the geographical and business reasons which lead to the grouping of several municipalities as the Greater Boston necessarily include a few places which produce nearly all of their local milk supply. In one or two instances—Milton especially—the place supplies milk to some of its neighbors. Over 7,000 cows are kept in the Greater Boston, located as follows:

Boston	850	Malden	169
Chelsea	87	Medford	282
Revere	168	Melrose	214
Winthrop	83	Newton	1,212
Quincy	656	Somerville	314
Milton	804	Stoneham	311
Winchester	240	Arlington	236
Woburn	362	Belmont	173
Watertown	281	Saugus	544
Waltham	882	Lynn	342

A third source of supply of outside milk is from territory contiguous to the Greater Boston, which can be reached by a drive of 10 to 15

miles. This region is quite thickly settled, and consumes considerable milk, yet it also produces much milk to sell in Boston, which is brought in by wagons. The inspector of the city of Boston reports 5,232 cans sold daily in his jurisdiction, aside from the railroad milk. The milk in other cities and towns of the Greater Boston not brought by rail must be 5,000 cans more. Two of the largest towns for milk shipments by team are Dedham and Bedford, from each of which nearly 1,000 cans are daily hauled.

This nearby milk, although only about one-fourth of the city supply, has shown a tendency to increase of late; its competition with railroad milk was unusually severe during the last few months of 1897. This has been because milk has been maintained at such an even price, because there has been an unusual disparity between the sale-milk value and the butter value of the product, and because prices of other farm products were so depressed that milk was relatively the most profitable farm product, in very many cases.

PROVIDENCE.

Providence, the second in size of the New England cities, has an estimated population of 150,000. The best estimates obtainable place the milk consumption at 75,000 quarts per day. This amounts to 27,375,000 quarts per year. This milk is sold from 407 peddlers' wagons and 900 stores, restaurants, bakeries, etc. Nearly all of the milk is produced within 20 miles of the city. Most of the milk that is brought in wagons comes an average distance of 12 miles, though a little comes 20 miles each day. The balance is carried by railroad. One car brings in 9,500 quarts per day. This car starts from Willimantic, Conn., a distance of 60 miles. About 4,000 quarts per day are carried on the other railroads in express and baggage cars. The milk is shipped, for the most part, in cans similar in general style to the Boston milk can, but containing $9\frac{1}{2}$ and $10\frac{1}{2}$ quarts.

The selling of milk from stores is more prevalent than in many other cities of New England. It is estimated that almost half of the milk consumed in this city is sold from stores instead of being delivered from house to house by peddlers. Most of the railroad milk goes directly to stores.

The price of milk for the last few years has been quite uniform, consumers paying usually a cent less in the summer than in the winter. The retail summer price ranges from 5 to 7 cents and the winter price from 6 to 8 cents. The wholesale price per can in the summer is at the rate of 15 or 16 cents per gallon, and 19 or 20 cents per gallon in the winter. About one-third of the nearby milk is sold by the producers themselves, who drive into the city every morning with their supplies, retailing from house to house. About two-thirds of the nearby milk is sold by peddlers who buy milk from the farmers. Some of them buy from middlemen, who pick up milk from the farmers and haul it to the city. In these cases the peddlers do not see or know the men who

produce the milk for them. These middlemen, however, differ from those in Boston in that they occupy a much less conspicuous place in the business than the Boston contractors and are hardly more than agents and teamsters for the city peddlers.

The producers receive 11 to 12 cents per gallon for milk in the summer, and 15 or 16 cents in the winter.

The population of Providence has increased from 120,000, in 1886, to 150,000 in 1896, or 25 per cent; but the consumption of milk appears to have increased about 122 per cent, only 33,700 quarts per day being reported in 1886. These figures show that there has been greatly increased consumption of milk per capita during the last few years.

Milk is from twelve to forty-eight hours old when it reaches the consumers in Providence.

OTHER CITIES.

The reports from the other New England cities are, for the most part, without novel features. To go into the details about each city would be mere repetition, to a large extent. The milk generally is brought into the city early in the morning by retailers who are, for the most part, producers. In some instances peddlers buy the supplies of farmers and act only as middlemen. In other cases the farmer supplements his own supply by buying from his neighbors. The milk is mostly produced within a dozen or fifteen miles of the city where it is consumed. The night's milk is not over 12 hours old when it reaches the consumers; the morning's milk not over 6. Consequently less pains are taken in cooling and caring for the milk than when it becomes 48 to 72 hours old before reaching the consumer. Six cents per quart is the average price to consumers. In some cities the price drops to 5 cents in the summer, and in a few instances 7 cents is reached in the winter.

The usual method of distributing milk is by pouring from the 8½-quart cans into the individual cans, pitchers, or bowls of customers at their doors, although some peddlers carry individual cans. The use of glass bottles is comparatively rare, though increasing. In many cities the old-fashioned wagons are giving way to vehicles built low-down expressly for the milk business. In many cases farmers who sell milk pay some attention to vegetables and small fruits, which utilizes help, insures an advantageous rotation of tillage, helps out the supply of manure, and assures a retail market for eggs, fruit, or vegetables.

Worcester, Mass., has a population of 110,000 at present, and annually consumes 2,076,000 cans, which is sold from 650 wagons and stores. It is retailed for the most part at 6 cents per quart, summer and winter. In the city and suburbs are a number of superior Jersey and Guernsey herds, for whose milk better prices are obtained. Worcester has a very efficient milk dealers and producers' association, which does much to promote uniformity in price and to keep up the quality. Many of the Worcester milkmen are market gardeners, who combine the two kinds of farming to advantage.

Most of the Lowell, Mass., daily supply of 3,511 cans comes directly from the farmers within a few miles of the city. But a Boston milk train passes through the city, and at times a little railroad milk is left. Milk retails for the most part for 5 cents per quart in the summer and 6 cents in the winter. One hundred and seventy-six milk dealers' licenses are issued in this city. The population is 84,000.

Burlington, Vt., uses about 365,000 gallons annually, which is sold by about 140 peddlers, many of whom are producers. The population in 1890 was 15,000, but it is estimated now at about 20,000. The per capita consumption of milk has increased materially during the past ten years. The trade has nearly doubled, while the increase in population is about one-third. Prices at retail range from 4 to 6 cents in the summer, and from 5 to 7 cents in the winter.

Augusta, Me., with a population of 12,000, uses 1,600 to 2,000 quarts of milk daily, mostly retailed at a uniform price of 6 cents the year around. The farmers who produce the milk for the most part retail it.

Portland, Me., uses the milk of about 4,000 cows, which amounts to about 2,250,000 gallons a year. Some of this milk is sent in by railroad in baggage and express cars. This is retailed by peddlers, who are mostly middlemen. The milkmen supplying the Portland market have an organization.

New Bedford, Mass., has 151 licensed dealers retailing 24,000 or 25,000 quarts per day; the retail prices are mostly 6 and 7 cents. Producers largely retail their own supplies.

Taunton, Mass., has 24 licensed dealers and uses about 12,000 quarts per day. The retail price is 6 cents summer and winter.

Hartford, Conn., licenses 152 regular retail dealers. An average of 26,000 quarts is sold daily. All is produced within 10 miles of the city.

THE CREAM TRADE.

The cream trade has increased rapidly in Boston, Providence, and other cities during the past few years. Formerly there was a small supply and limited demand. The business was not pushed. A person who wanted cream could in most cases be supplied by his milkman, and the large Boston contractors did quite a cream trade. Still, cream was generally looked upon as a special luxury. The increasing use of the separator helped to develop the business, making it more easy than ever before to secure sweet cream of good keeping qualities.

The great increase in the cream business, however, has been due to the systematic business-like push and enterprise of a few Maine creameries. This business began in the latter part of the eighties. The cream is sent in 6-gallon cans, packed in ice, by express on fast trains, reaching Boston about 6 o'clock in the morning. It is there received by agents of the proprietors, put into half pint, pint, and quart glass jars, and delivered at once. It is not only delivered direct to families, but is a common and staple article of merchandise in the grocery stores in

Boston, Providence, and other portions of southeastern New England. Many stores which took experimentally only one or two cans to begin with, found their trade rapidly increased, as the public quickly "caught on" to the possibility of getting cream of reliable quality and good condition for keeping.

This cream is of uniform quality, heavy and rich, being about 45 per cent butter fat, is put up in attractive and convenient form, and keeps well. This has stimulated a growing demand.

Such signs as "Bangor cream," "Hampden cream," "Wallingford cream," are now a frequent and familiar sight in a majority of grocery and provision stores. The cream is retailed in Boston at 60 cents per quart.

One establishment shipping cream from Maine makes the following report of its business for the last three years, showing the increase in the use of cream. The figures are for gallons:

Thick cream, 47 per cent butter fat.

	1894.	1895.	1896.	First six months of 1897.
Boston and vicinity.....	33,466	40,141	43,542	28,034
Beverly, Lynn, and Salem.....	8,033	8,811	9,432	4,333
Places outside of Massachusetts.....	1,531	1,476	1,502	1,564
Total.....	43,030	50,428	54,476	33,931

Thin cream, 18 per cent butter fat.

	1894.	1895.	1896.	First six months of 1897.
Boston and vicinity.....	667	6,645	12,618	4,925
Lynn, Salem, and Beverly.....	702	702	1,969	914
Total.....	667	7,347	14,587	5,839

Other Maine creameries are also making large shipments. Faster railroad trains are said to be necessary to still further develop this cream trade. The creameries are mostly proprietary, buying milk of the farmers. As a rule there are no particular feeding materials to which objections are raised to the farmers using, but much pains are taken to impress the great importance of cleanliness in every detail of the business.

SKIM MILK.

The skim milk problem is of considerable importance in the city of Boston. As we have shown above, a great deal of the surplus milk is made into butter after it reaches the city. Consequently, there is a supply of skim milk more than usual in such a center. A great deal of this is allowed to run into the sewers, as there is no market for it; some *is sold*, and some is returned to the farmers, but the greater part is

thrown away. - This is a great loss of food material, and if the people of the city could realize the food value of skim milk, and could buy it at a reasonable price, much good would result. But as ordinarily sold, a quart of skim milk too often replaces a quart of whole milk, and thus to that extent injures the sale of whole milk. Further than that, skim milk is to quite an extent used to adulterate whole milk; just how much no one can say. When milk is adulterated with water, the amount of solids not fat is reduced in the same proportion as the fat, and the abnormally low amount of solids not fat is evidence of the work of adulteration. But when the adulterant used is skim milk, the solids not fat remain the normal amount; consequently, the adulteration is more difficult to detect; hence, more dangerous.

In the other cities there is something of a sale of skim milk, but it is much less, that in Lowell, for instance, amounting to 2,227 quarts per day. The most of this skim milk sold out of Boston is sold honestly as a valuable food product.

The use of buttermilk is not so extensive as it ought to be, and yet in some cities considerable goes into consumption. In Lowell something like 850 quarts per day are sold. - In Worcester the product of one or two creameries is retailed each day. But speaking in a general way, the sale of buttermilk is quite small.

CONDENSED MILK.

The use of condensed milk is increasing, especially in Boston. A large city collects many people who are compelled to keep house in restricted quarters; in not a few instances shop and office girls practice light housekeeping in a single room. In these and other cases the can of condensed milk is a convenient article. New England has six condensed-milk factories, and the product from the West and even from abroad is also sold in the grocery and provision stores.

MILK CONSUMPTION PER CAPITA.

The consumption of milk per capita is a very difficult thing to get at, and statistics on this point must necessarily be more or less faulty. An effort has been made to gain information on this subject and a careful investigation of the quantity of milk sold in a number of cities has been made, and the amount ascertained has been divided by the population. The result is remarkably uniform, as follows (the figures indicate hundredths of a quart used daily per capita of population):

Boston	.48	Haverhill	.45	Nashua	.41
Lowell	.33	Burlington	.50	Lawrence	.40
Hartford	.47	Worcester	.44	Pittsfield	.30
Nashua	.42				

In all of these cases it must be remembered that an element of uncertainty exists in the degree of accuracy in the reports of the amount of milk sold with which we have been furnished, but the results are so

uniform that it is hardly fair to suppose that an equal error could have been made in every case. Therefore it seems reasonable to assume, in a general way, that the consumption of milk in Massachusetts cities is a little less than a pint per person per day—a little over four-tenths of a quart. In no case does this include the sales of skim milk, condensed milk, or cream.

MILK LAWS AND INSPECTION.

LEGAL STANDARD AND ADULTERATION.

All of the New England States have laws prohibiting the sale of adulterated or watered milk, or milk from which a portion of the cream has been removed. All of the States except Connecticut have a statute standard for milk.

Massachusetts prohibits the sale of milk "not of standard quality," as well as of adulterated milk, and the following statute defines standard milk:

If the milk is shown upon analysis to contain less than thirteen per cent of milk solids, or to contain less than nine and three-tenths per cent of milk solids exclusive of fat, it shall be deemed for the purposes of this act to be not of good standard quality, except during the months of April, May, June, July, and August, when milk containing less than twelve per cent of milk solids, or less than nine per cent of milk solids exclusive of fat, or less than three per cent of fat, shall be deemed to be not of good standard quality.

Nearly all of the cases entered in court for the violation of these milk laws complain of the offender for selling, or having in his possession or custody with intent to sell, "milk not of standard quality," instead of "adulterated or watered milk."

The Rhode Island law provides that—

If the milk shall be shown upon analysis to contain more than eighty-eight per centum of watery fluids, or to contain less than twelve per centum of milk solids, or less than two and one-half per centum of milk fats, it shall be deemed for the purpose of said sections to be adulterated.

The New Hampshire law says that if milk has less than 13 per cent of milk solids said fact "shall be prima facie evidence" that the milk is adulterated. But evidence that milk has less than 13 per cent solids is frequently rebutted by producing or offering to produce some cow which gives milk of less than 13 per cent solids, and therefore the whole law is nullified.

In Maine, "when milk shall be found to contain over 88 per cent of water it shall be deemed prima facie evidence that said milk has been watered, and when milk by the analysis aforesaid shall be found to contain less than 12 per cent of solids and less than 3 per cent of fat it shall be deemed, prima facie, milk from which cream has been taken." This is similar to the New Hampshire law, but we have heard no complaints from Maine over the words "prima facie."

Vermont, like Massachusetts, prohibits the sale of milk "not of good standard quality," as well as adulterated milk, milk from which a por-

tion of the cream has been removed, etc. The Vermont statute defines standard milk as follows:

Standard milk shall contain not less than twelve and one-half per cent of solids, or not less than nine and one-fourth of total solids exclusive of fat, except in the months of May and June, when it shall contain not less than twelve per cent of total solids.

The laws of the several States also have regulations for promoting honesty in sales of skim milk, such as labeling cans, etc.

Wine measure is by law the standard measure.

OFFICIAL INSPECTION.

All of the States except Vermont and Connecticut have special laws providing for the enforcement of these milk regulations.

In Massachusetts, cities are required and towns are allowed to appoint milk inspectors. In Boston the present milk inspector is a man of ability and energy. He has a respectable salary and sufficient appropriation for collectors of samples, laboratory, etc. Hence the work of milk inspection in that city is very efficiently performed. The following statistics of his work show how thorough it is, and also, inferentially, something of the quality of the Boston supply, the ratio of samples taken to court cases being very small.

Year.	Samples taken.	Cases in court.	Year.	Samples taken.	Cases in court.
1886	8,701	88	1893	13,623	293
1888	9,484	67	1895	12,587	316
1890	13,853	220	1897	12,295	129

In a number of other Massachusetts cities—Lowell, for instance—good work is also done; but in most cases the salary is nominal and the work corresponds, though most of the inspectors earn more than they get. Very few of the towns avail themselves of the permission to appoint inspectors. To cover the field where local inspection is weak, the State board of health and the State dairy bureau are also given authority to enforce the dairy laws. The following statistics show the work of the board of health, scattered over the State:

Year.	Samples taken.	Court cases.	Year.	Samples taken.	Court cases.
1890	3,236	24	1893	3,073	67
1891	2,726	49	1894	3,551	76
1892	3,271	72	1897	6,104	48

Convictions followed in about 90 per cent of the cases.

Rhode Island has a law similar to Massachusetts as regards local milk inspectors. New Hampshire law permits the appointment of such officers. In Maine, cities and towns of not less than 3,000 inhabitants must appoint milk inspectors. In most cases, however, in all of these

States there is little inspection and in many cases no inspector. Particular mention should be made of the good work in Providence, R. I., Nashua, N. H., and Hartford, Conn. The inspector of the latter city is appointed under the provisions of a city ordinance.

The regulations in the different States as to the duties and authorities of milk inspectors are similar. The inspectors and collectors of samples employed by them are authorized to enter all places where milk is stored or kept for sale and all carriages used for the conveyance of milk and take samples for analysis from all such places or carriages.

The laws of the different States where there are milk inspectors provide for registering and licensing milk dealers for a nominal fee. This is done for the purpose of securing proper identification of the dealer.

The legal supervision hitherto noticed has related almost entirely to the commercial fraud of selling less food than the purchaser supposes he is receiving for his money—*i. e.*, milk watered, skimmed, or naturally of less than average quality.

SANITARY LAWS AND INSPECTION.

All of the States have laws relative to the healthfulness of the milk supply. Massachusetts, Maine, Rhode Island, and New Hampshire prohibit the sale of milk from sick or diseased cows or cows fed upon the refuse of breweries or distilleries or upon any substance deleterious to its quality. Connecticut prohibits the sale of "impure milk" and milk from cows which shall have been adjudged by the commission upon diseases of domestic animals to be affected with tuberculosis or other blood disease. A Massachusetts law imposes a fine upon "whoever knowingly feeds or has in his possession with intent to feed to any milch cow any garbage, refuse, or offal collected by any city or town."

There is, however, no especial sanitary inspection of milk and its sources in any New England town or city, and cases are rarely brought in court for violation of any of the above sanitary laws. The milk inspection now in vogue relates almost exclusively to commercial frauds rather than to health matters. The Massachusetts state board of health has done some good work in investigating several typhoid-fever epidemics, which in a number of cases have been traced to the milk supply. Local boards of health, however, have considerable authority, and in several cases they have issued orders or made regulations in advance of the average practice of the State. Hartford, Conn., Portland, Me., and Lynn, Mass., are instances. The contagious-cattle-disease law of Massachusetts provides for a cattle inspector in each town, who makes a semiannual inspection of neat stock, quarantining suspected animals, which are subsequently tuberculin-tested, and if found to be diseased are destroyed. In a few instances—Pittsfield, for example—the milk inspector and cattle inspector are one and the same person, which is a decided advantage.

The milk inspector of Nashua, N. H., has a unique and commendable system of sanitary inspection of the milk supply of that city, which is said to work well. Although his official powers are confined to the city limits and to the commercial fraud of selling adulterated or low-grade milk, all peddlers—mostly producers—are required to answer the following questions when they register:

1. Name of owner? 2. Number of cows? 3. Number of each breed? 4. Food of cows? 5. How is manure stored? 6. Quantity of milk produced per day? 7. Where is milk stored? 8. How is milk cooled? 9. Temperature of milk when sold? 10. Source of water supply for stock and for washing cans? 11. Distance of water supply from barnyard; from privy vault; from cesspool? 12. Are any cows sick upon your premises; if so, how many, and with what disease? 13. Are any persons engaged in handling milk sick?

The inspector also calls from time to time on the farmers who produce milk for the city, even when they reside out of his official jurisdiction. He makes such investigation of the premises as he is permitted, and reports to the board of aldermen the condition of affairs. The board then orders the report published in the local papers. To most milk producers the publicity of an unfavorable milk report is more of a punishment than a court fine, while a favorable report is a valuable advertisement. Hence, as much is accomplished as if there were more stringent laws, and there is none of the friction that might arise from over-officiousness or unpopular official prying. He also issues the following:

[Circular.]

CITY OF NASHUA, N. H.,
DEPARTMENT OF MILK INSPECTION.

The importance of education in the better care of milk is so great that I feel it a duty to call attention to certain precautions necessary to a good product. The average farmer has so many cares that he sometimes fails to give this important subject proper attention.

Milk in the udder of the healthy cow contains none of the microorganisms of fermentation or decay, and could it be drawn thence into an hermetically sealed receptacle, without coming in contact with the air, it would keep without change for an indefinite time. Of course this is not practicable in an ordinary dairy, but care can certainly be exercised that the surrounding atmosphere with which it does come in contact is as free as possible from germs, odors, or taints, for these the milk absorbs with great rapidity.

Milk which has stood for ten minutes in an open vessel in a tainted atmosphere will be found to contain from 10,000 to 100,000 germs per cubic centimeter (a cubic centimeter represents about one-third of a cubic inch), while in two hours from 2,000,000 to 5,000,000 germs will be found per cubic centimeter. This prodigious increase can be stopped by removing the milk to a proper cooler. I have explained the necessity of pure water and wholesome food for cows so often before that I will not repeat it. But I wish to call attention to the following precautions in the handling of milk:

All stables should be ventilated.

They should be as clean as possible.

Cows should be carefully groomed.

The milk should be drawn from the cow as rapidly as possible.

The milk should not be left standing in the stable a moment longer than necessary.

The cooler should be so remote from the stable that no odors can reach it.

Its temperature should be at from 45° to 50° F., and

The milk should be aerated to remove animal odors.

Under these improved conditions cows not only yield better milk but more of it, and amply repay the labor and trouble expended upon them.

There are in this vicinity dairies infamous alike in their cruelty to animals, in their brutalizing influence upon men, and in their disease-spreading effects upon infants and the general community; but I believe that a vast majority of our farmers desire to do right if but the means and knowledge were presented to them.

I. F. GRAVES, *Inspector of Milk.*

Health orders.—The board of health of the city of Boston has the following regulation:

Whereas cows' milk is one of the most common and necessary articles of food, and is oftentimes seriously impaired in usefulness and rendered dangerous to health by the want of proper care in its production or subsequent treatment and handling; it is, therefore, ordered that the following regulation be and is hereby adopted:

SECTION 1. No person shall use any building as a stable for cows unless it contains at least 1,000 cubic feet of space for each animal, is well lighted and ventilated, has tight roof and floors, good drainage, a supply of pure water, and all other necessary means for maintaining the health and good condition of the cows, and has been approved by the board of health.

SEC. 2. Every person using any such building shall keep the same and the premises connected therewith, and all land used for pasturage of the cows, clean and free from filth.

SEC. 3. Every person keeping a milch cow shall permit it to be examined from time to time, as to its freedom from disease, by a veterinarian designated by the board of health.

SEC. 4. No person having an infectious disease, or having recently been in contact with any such person, shall milk cows or handle cans, measures, or other vessels used for milk intended for sale, or in any way take part or assist in handling milk intended for sale, until all danger of communicating such disease to other persons shall have passed.

SEC. 5. No person shall sell or use for human food the milk of a diseased cow, or permit such milk to be mixed with other milk, nor until it has been boiled shall use such milk, or any mixture of such milk, for food of swine or other animals.

QUALITY OF MILK SOLD.

The word quality when applied to milk may mean the amount of milk solids (which is the best acceptance) or it may have reference to flavor, disease germs, bacteria of decay, etc. From what has been said above it will be seen that in whatever sense we use the word the quality of milk receives considerable attention, especially as to its composition.

In Massachusetts the law creating a legal standard of 12 and 13 per cent is well enforced, and milk in the market usually averages even above the standard. All of the large Boston wholesalers employ chemists, who devote all of their time to testing the supplies which they receive. If the milk of any dairy is below the statute standard, warning is sent to the producer, and if the warning does not result in an improved quality of milk the supply from that dairy is dropped. In some instances where there is unmistakable evidence of watering the

case is turned over to State officials for prosecution. This unofficial inspection weeds out a lot of milk that might be below the standard before it is put on the market, and insures to peddlers the purchase of milk that will not get them into trouble.

In Providence a lower standard exists than in Massachusetts, which causes the milk inspector some trouble. Most natural milk has over 12 per cent of solids. A small amount of water can be added to 13 or 14 per cent milk without changing the proportion of fat and solids not fat sufficiently to warrant a verdict against the adulterator. Most judges will convict only when the milk is below the statute standard, and do not feel convinced of the guilt of the defendant on the simple assertion of a chemist that the relation of fat and solids not fat is such as to create a certainty that the milk is adulterated.

In the smaller cities and towns statistics from samples of milk taken by various officials show, usually, a higher quality than samples from milk sold in Boston or Providence, although the milk in those places is up to the statutory standard, for the closer the contact between the producer and consumer the better the quality of the milk. The occasional meeting of producer and consumer, face to face, has a tonic and stimulating effect on the former, which tends to keep up the quality of the milk supply. One of the disadvantages of shipping milk by railroad is that the producer never sees the consumer, oftentimes not even the peddler, and has no interest in his supply further than to avoid a word of warning from the contractor's chemist.

Milk substantially above the statutory standard is more frequently found among farmers retailing their own milk supply direct to consumers than elsewhere.

The following is the result of analyses of milk taken from milkmen by officers of the Massachusetts Dairy Bureau in the regular discharge of their routine duties, and throws an accurate sidelight on the per cent of solids sold. These samples were taken in May and June, when the legal standard is 12 per cent.

Worcester: Samples from 28 milkmen ranged from 12 to 14.34 per cent total solids and averaged 13.06 per cent.

Taunton: Five samples ranged from 12.54 to 14.28 and averaged 13.50 per cent.

New Bedford: Thirty samples ranged from 11.84 to 15.02 and averaged 13.30 per cent; 14 of them were above this average.

The following are the figures of four days' routine work of the Boston milk inspector. The standard for July is 12 per cent.

Inspections for four days in July.

	26th.	27th.	28th.	29th.
Samples from shops Number..	20	9	19	0
Samples from wagons do...	30	21	31	30
	50	30	50	30
Above the standard:				
From shops do ..	19	9	18	0
From wagons do ..	30	20	31	27
	49	29	49	27
Below the standard:				
From shops do ..	1	0	1	0
From wagons do ..	0	1	0	3
	1	1	1	3
Poorest sample above standard Per cent..	12.12	12.06	12.06	12.25
Poorest sample found do ..	11.92	11.96	11.20	11.40

The Providence milk inspector reported that he examined 24 samples of milk on the 24th of July and 47 samples on the 26th, and found the results as follows:

Number of samples.	Total solids (per cent).			Fat (per cent).			Solids not fat (per cent).		
	High-est.	Low-est.	Aver-ge.	High-est.	Low-est.	Aver-ge.	High-est.	Low-est.	Aver-ge.
24	13.75	11.10	12.60	5.00	3.00	3.81	9.40	7.50	8.80
47	* 14.35	† 9.65	12.21	* 6.00	2.20	3.59	9.39	† 7.25	8.63

* Same sample.

† Same sample.

This inspector remarks: "This does not represent the average quality of the milk sold in Providence, neither would the figures obtainable for any other two days, unless by chance."

The following figures are from the inspector of milk at Lowell:

	Per cent.	Number of samples.
Average solids for February, 1897	13.42	197
Average solids for June 5, 1897	12.96	237
Average solids for June 21, 1897	13.06	23
Average solids for July 19, 1897	12.82	24

The above figures will give some idea of the amount of solid matter in milk as sold in New England cities.

Regarding milk in the second sense of the word "quality," we are confronted by two positive opinions, and those apparently very contradictory. In spite of the healthfulness of the Boston milk supply, Professor Sedgwick, of the Institute of Technology, a bacteriologist of note, embraces every opportunity to criticise Boston milk.

On the other hand, Dr. Conn, of Wesleyan University, a well-known bacteriologist who has made dairy products a special study, says what might be construed as a flat contradiction—that Boston has probably a better milk supply than any other city in the world. There is doubtless truth in both statements, their seeming inconsistency being explained by the different standpoint of the two students. One speaks from the

standpoint of the idealist, and finds much that needs condemnation; the other speaks of things comparatively, as he finds them in many places.

Much of the milk supply of Boston comes from such distances that the selfish interests of the producers compel precautions that otherwise would be unnecessary. Filthy milk, drawn under indifferent conditions, will not be sweet and wholesome when from 40 to 70 hours old. Consequently, the railroad milk must be, even without legal requirement, more or less carefully attended to. Many of the farmers who ship milk to Boston have ice or running spring water for the quick and immediate cooling of milk, and if their methods get too slovenly the fact is recorded in the poorer keeping qualities of the milk, and sometimes in its return as sour. It is often the fact that the precautions necessary to care for this milk shipped from a distance are such that after arriving in the city it will keep longer than milk from nearby, the producer of the latter not taking so much pains because the milk was to be delivered at once.

The general dissemination of information as to the bacteriological cause of milk's souring—the work of colleges, experiment stations, and newspapers—is leading farmers to become more and more particular in regard to cooling it as soon as possible after milking, and taking the other necessary precautions for the purpose of insuring its keeping. Another influence, however, is pulling the other way. Quite a change in the nationality of the farmers is going on. Farms are passing from the native New England stock into the hands of those more recently descended from other countries, thrifty, industrious people, and good citizens, but for the time being in some instances they are not as well informed in the latest and best agricultural methods. They are not book farmers, and frequently a change of farm owners means a temporary deterioration in the milk supply from that farm.

The methods of some city peddlers are open to criticism; their milk headquarters and their stables are often one and the same building, and sometimes the mixing and canning is not done under perfectly clean conditions.

Outside of Boston the milk supply is reasonably good, as the times go. A general improvement in the supply of the different cities is reported by correspondents. They say that the farmers producing milk are generally reliable and honest; that it is for the most part cooled in running water or ice tanks, and that great improvement has been made during the last few years. Nearly all, however, urge further advances along this line; and while most of the correspondents not only note improvement but claim that their town or city compares well with others, they recognize room for further improvement, and call especial attention to the need of more cleanliness in every department—in vehicles, cans, and the milkmen themselves. Some emphasize the importance of more care in cooling and aeration.

The general attention which has been given to tuberculosis during the past few years has resulted in the destruction of many tuberculous herds, and this has doubtless had a beneficial effect on the milk supply. All of the New England States, except possibly Rhode Island, have had popular agitations of this subject, and sharp dissension has arisen. The point in dispute has been whether the degree of danger from tuberculous milk was sufficient to warrant the public expense and losses to cow owners incident to radical measures in combating the disease. Whatever may be the views of different persons on this subject, all must admit that many tuberculous herds have been exterminated, and that this, at least, can not have injured the milk supply. As a result of this agitation, every town in Massachusetts has a cattle inspector, who makes a semiannual examination of the cows in his town. His official authority is confined to quarantining suspected animals, but the system has done much good in a suggestive way, in improving ventilation, increasing the amount of light, and reducing the uncleanness of stables.

On the whole, the milk supply of New England cities seems reasonably up to the best average practice of the present times.

NEED OF ADVANCED PRACTICES.

As to more advanced practices, however, it seems that very little is being done. The ideal way of selling milk is not on a dead level at one price, but on its merits and at a price proportionate to quality. A little is already being done in this direction, and a number of dairymen with Jersey or Guernsey herds sell milk above the going price. But we know of no milk sold on a guarantee of its content of solids. It commands an extra price because people know that the milk of such cows is richer than the milk of other cows, and also because it has an improved quality in other directions.

A large dairy farm in Worcester County has for years run to Boston a car of milk from superior Jersey herds, which has been sold above the current price for milk, for the most part at 10 cents per quart. No specific amount of total solids has been guaranteed, but the milk has been better than 13 per cent—nearer 15. When individual glass bottles first came in vogue this company was a pioneer in their use, and later when tuberculin was discovered it was the first to advertise milk from tuberculin-tested cows. Indeed, it still produces the only milk so advertised and sold in Boston. Great pains is taken with the milk on the farm and it is always in good condition.

A resident of the city of Newton, a residential suburb of Boston, has developed a milk business calling for the product of about 150 cows. The milk is sold within a narrow radius to people who might be called his neighbors, who have seen or heard of his methods, and who desire the milk. His cows are Jerseys, tuberculin-tested, kept in one-story barns, with no manure cellar underneath and no hay lofts

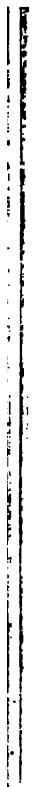
overhead. Light and ventilation are ample. Scrupulous cleanliness prevails. Great pains is taken to promote the comfort of the animals. The newest barn has no stanchions, but provides a box stall 7 by 9 feet for each cow. The milk is run through a cooler as soon as drawn, and kept cool by artificial refrigeration—ammonia process. It is then bottled in glass jars, being at a temperature of 38 to 40 degrees, and delivered at once to customers. There are two deliveries a day, and the milk is not over two hours old when in the hands of consumers.

The use of glass jars for the delivery of milk is growing and is somewhat common, though used as yet by a small minority of milkmen. Pasteurizing milk is done only to a limited extent. Here and there some pioneer has entered into this field. The Massachusetts Agricultural College and one or two enterprising dairy farmers within reach of Boston have recently added pasteurizing apparatus to their dairy equipment, and are selling sterilized milk and cream. The number who sell pasteurized milk, in proportion to the whole, is extremely small; still there has been a satisfactory beginning, and frequently additions are made to the number of those who are advancing in this direction.

The pasteurizing of cream is more common. Some of the concerns who supply cream in a wholesale way pasteurize all of their output to enhance its keeping qualities.

A company started in Boston several years ago the sale of "modified" milk. By patent processes this "laboratory" prepares from cream, skim milk, and sugar of milk a compounded milk of any desired composition, for infants and invalids. The company has its own herd of cows, well cared for, to supply the milk.

Some of the large milk dealers of the city are experimenting with filtered milk, and introducing it on a limited scale. The process enhances its keeping qualities, and the milk so treated has been shown by microscopical examination to be almost as free from bacteria as pasteurized milk.



BULLETIN No. 21.

(B. A. I. 116.)

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

SHEEP SCAB:

ITS NATURE AND TREATMENT.

BY

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1898.



LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., March 15, 1898.

SIR: I have the honor to transmit herewith, for publication as a bulletin of this Bureau, a discussion of "Sheep Scab: Its Nature and Treatment." The disease known as scab is one of the most serious drawbacks to the sheep industry and results in enormous financial losses. Yet, despite its insidious nature, its ease of transmission, its severe effects, and its prevalence in certain localities, it is a disease which yields readily to proper treatment. If all of the sheep owners of the country would dip regularly and thoroughly, there is no reason why this scourge should not be totally eradicated from the United States. There should be stringent scab laws in every State, with State inspectors to see that those laws are carried out.

The sheep raisers of this country are intelligent and progressive men, and most of them fully recognize the necessity of combining to eradicate this disease. In many cases, however, more particularly among owners of small flocks, there are many erroneous ideas prevalent regarding the exact nature of the disease and the methods by which it may be eradicated. It is to meet the demand for exact information on this subject that this bulletin has been prepared. In it will be found a description of the various kinds of scab, references to conditions which may be mistaken for scab, a description of various kinds of dipping plants suitable for use on small and on large farms, directions for preparing certain homemade dips, and directions for dipping. The investigation of various kinds of dips will be continued by this Bureau, and supplementary circulars will be published if necessary.

In the preparation of the bulletin the writers have received valuable assistance from Dr. Schroeder, Director of our Experiment Station.

Respectfully,

D. E. SALMON,
Chief of Bureau of Animal Industry.

Hon. JAMES WILSON,
Secretary.



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SHEEP SCAB: ITS NATURE AND TREATMENT.

HISTORICAL INTRODUCTION.

The disease commonly called sheep scab is the mange, or scabies, of the sheep. It is a contagious skin disease caused by a parasitic mite. This disease is one of the oldest known, most prevalent, and most injurious maladies which affects this species of animals. It has been well known for many centuries, and references to it are found in the earlier writings, including the Bible, where we find, in Leviticus, xxii: 22, the use of scabbed sheep forbidden in sacrifices. Some think that the mite which causes the disease was known to Aristotle, 322 B. C.; but it appears that Wichmann, writing in 1786, was one of the first authors of modern times to suspect that sheep scab was of the same nature as the scabies of man. Wichmann held the erroneous view, however, that both diseases were produced by the same parasite.

The prevailing opinion concerning scab prior to and during the first years of the present century was that it was caused by some special condition of the sheep's system, a "humor of the blood," which led to a skin eruption. The parasites were in some cases known and recognized, but they were supposed to be either an accidental occurrence or to have arisen by spontaneous generation as a result of the disease, and because the affected skin offered conditions favorable to their development and existence.

As a result of diligent research, certain investigators reached the conclusion that the malady was due directly to the mites which were found inhabiting the diseased parts of the skin. Their opinion was not at once adopted; however, but, on the contrary, met with strong opposition from those who held that scab was due to a diseased condition of the blood and from others who held a modified view to the effect that the mites carried poisonous or diseased material from one animal to another and in that manner communicated the disease. The errors and uncertainties which came down to us through centuries of controversy were finally and for all time dispelled by conclusive experiments upon animals made during the first half of this century. It was shown that scab does not develop and can not be produced without the parasites. The complete life cycle of the mites was studied and demonstrated from the eggs to the adult parasites. It was shown that mites are always the offspring of ancestors, the same as are the larger animals, and it has in later years come to be admitted that there is no such thing known

as spontaneous generation of any living thing under any circumstances. The demonstration was repeatedly made that the disease always developed if mites were taken from diseased sheep and placed upon healthy ones, and that diseases of the skin resembling scab are not contagious unless the mite is present.

Questions are still frequently asked, by persons not conversant with the investigations of the subject, as to whether the scab is the cause of the mite or the mite is the cause of the scab, and also whether the disease can develop without the presence of the scab mite. The investigations which have been referred to answer these questions and also show that the treatment must consist in external applications for the destruction of the parasites and not internal remedies to "purify the blood."

Is scab hereditary?—An impression has arisen among some sheep raisers that scab is hereditary. This impression is, however, erroneous. Scab is no more hereditary than are sheep ticks or sheep lice, for the parasites which cause it live on the external surface of the body and do not reach the womb. It is possible, however, for a lamb to become infected from a scabby mother at the moment of birth or immediately after. Lambs are occasionally born with white spots on their skin, and this possibly has given rise to the idea that scab is hereditary.

LOSSES CAUSED BY SCAB.

Losses in home industry.—The losses from sheep scab have been and are still very severe in most sheep-raising countries. They are due to the shedding of the wool, the loss of condition, and the death of the sheep.

Although laws were made for the control of the disease as early as the beginning of the eleventh century, general ignorance in regard to its nature and proper treatment has prevented the successful administration of such laws even to the present day. The disease exists in most of the countries of Europe, and also in Asia and Africa, and until recently in Australia. Most civilized countries now control the disease to a certain extent, and limit the losses by the enforcement of stringent sanitary regulations; but the extent of its prevalence is nevertheless surprising. It is a disease not difficult to cure and eradicate, and an accurate knowledge of its characteristics with attention to details are all that is needed to secure this result.

In the United States some sections have been overrun with sheep scab, and many persons engaged in the sheep industry have been forced to forsake it because of their losses from this disease. It is probable that in its destruction of invested capital sheep scab is second only to hog cholera among our animal diseases. The large flocks of the Plains and Rocky Mountain region and the feeding stations farther east have suffered severely and are constantly sending diseased animals to the great stock yards of this country. As a consequence of this marketing of affected sheep, the stock yards are continually infected, and any

sheep purchased in these markets are, unless properly dipped, likely to develop the disease after they are taken to the country for feeding or breeding. There is in this way a constant distribution of the contagion, and thousands of persons who know little of its nature or the proper methods of curing it find that they have introduced it upon their premises.

Losses in export trade.—In addition to the direct losses in wool, in flesh, and in the lives of our sheep, we have suffered immensely in our foreign trade because of the prevalence of this disease. Great Britain appears to have been the first country to prohibit live sheep coming from the United States, by an order issued in 1879. Upon representations that there was no foot-and-mouth disease in the United States this order was rescinded in 1892, but only to be again enforced in 1896 on account of the many scabby sheep sent abroad by our exporters. Our sheep are consequently slaughtered on the docks where landed, the market being restricted and the prices much less favorable than would otherwise be obtained. The markets of Continental Europe have been entirely closed to American sheep, as even the privilege of slaughtering at the landing places is denied. For a long time it was impossible to send our pure-bred sheep to Australia, where there is a demand for them for breeding purposes, because the Australian law required them to be transshipped and quarantined in British ports, and the British authorities declined to grant this privilege. Arrangements have since been made for the direct shipment of sheep to Australia, if accompanied by the certificate of a veterinarian appointed by the Australian authorities.

On the whole, it is seen that the existence of this disease in our flocks has prevented the development of our export trade in many directions, and has caused no end of trouble and loss to our exporters.

CAUSE OF SCAB.

Sheep scab is a strictly contagious disease.

Common sort.—Common sheep scab is caused by that species of mites technically known as *Psoroptes communis*.¹ Parasites of this species cause scab in horses, cattle, sheep, goats, and rabbits; but for each of these species of animals there appears to be a distinct variety of this parasite. Although it is more or less difficult to distinguish between these varieties, they differ somewhat in size, and it is found that the *Psoroptes communis* of the sheep does not cause scab of the horse, ox, or rabbit; nor, on the other hand, does the *Psoroptes communis* of the horse, ox, or rabbit cause scab of the sheep. Natural-

¹The technical term *Psoroptes* is derived from the Greek, and means that the mites hide under the crusts. The parasite is sometimes called *Dermatocoptes*, which means that the mites wound the skin. A third name, *Dermatodectes*, indicates that the mites bite the skin.

ists, therefore, distinguish the parasite of sheep scab by the name *Psoroptes communis* var. *ovis*.¹

The parasite of this disease is one of the larger mites, and is quite easily seen with the naked eye. The adult female is about one-fortieth inch long and one-sixtieth inch broad; the male is one-fiftieth inch long and one-eightieth inch broad. These mites are discovered more readily and more clearly on a dark than on a light background, and for that reason the crusts from the affected skin are often placed upon black paper and kept in the sunshine for a few minutes in order to reveal the parasites crawling about.

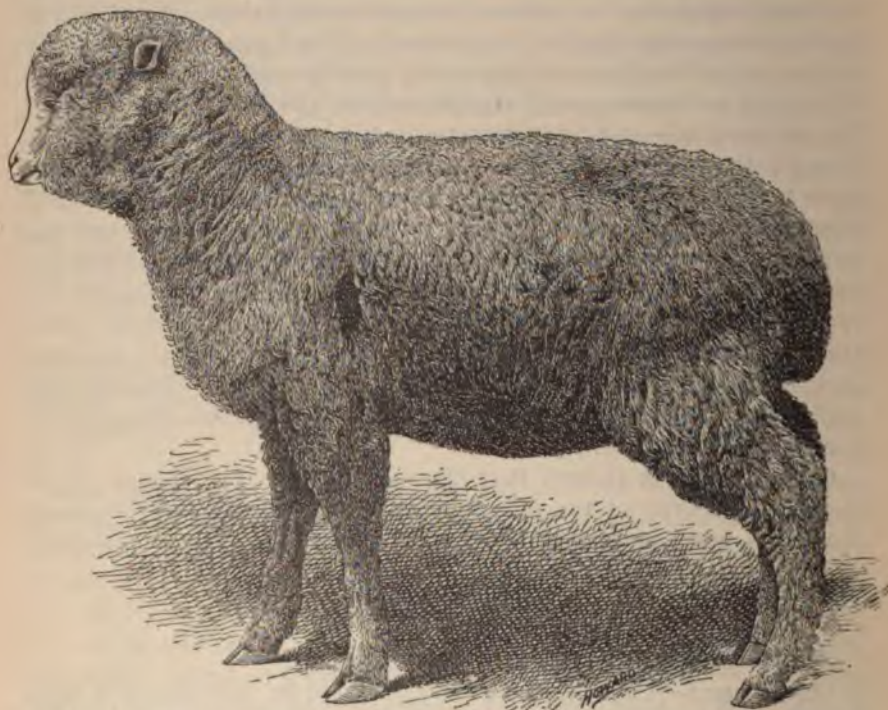


FIG. 1.—A comparatively early case of common scab, showing a bare spot and a tagging of the wool.

The psoropt inhabits the regions on the surface of the body which are most thickly covered with wool; that is, the back, the sides, the rump, and the shoulders. It is the most serious in its effects upon sheep of any of the parasitic mites, and it is the cause of the true body scab.

Other forms.—Sheep are also affected with three other forms of scab, likewise caused by parasitic mites. One of these is the sarcoptic scab (head scab, or black muzzle), which is limited almost entirely to the head, and is caused by the mite known as the *Sarcoptes*

¹Var. is the abbreviation of the Latin word *varietas*, meaning variety.



FIG. 1. A SLIGHTLY ADVANCED CASE OF COMMON SOAB.

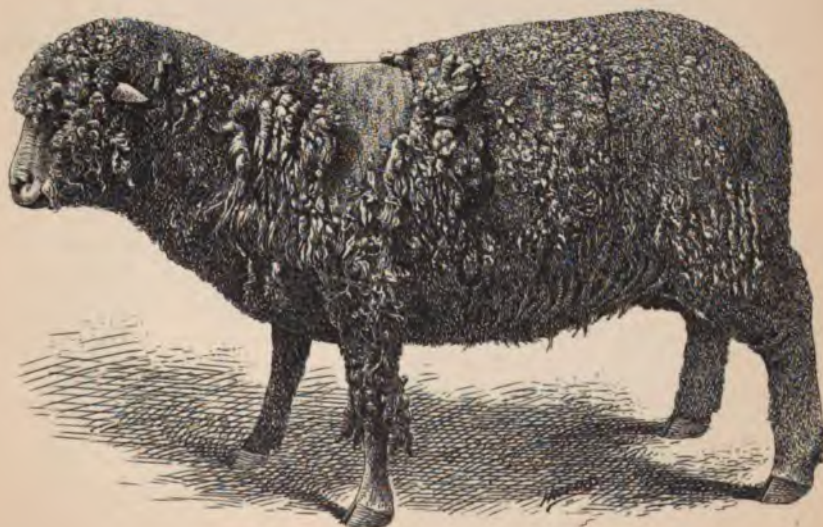


FIG. 2. A MORE ADVANCED CASE OF COMMON SOAB.

1. The first part of the document is a list of names and addresses of the members of the committee.

2.

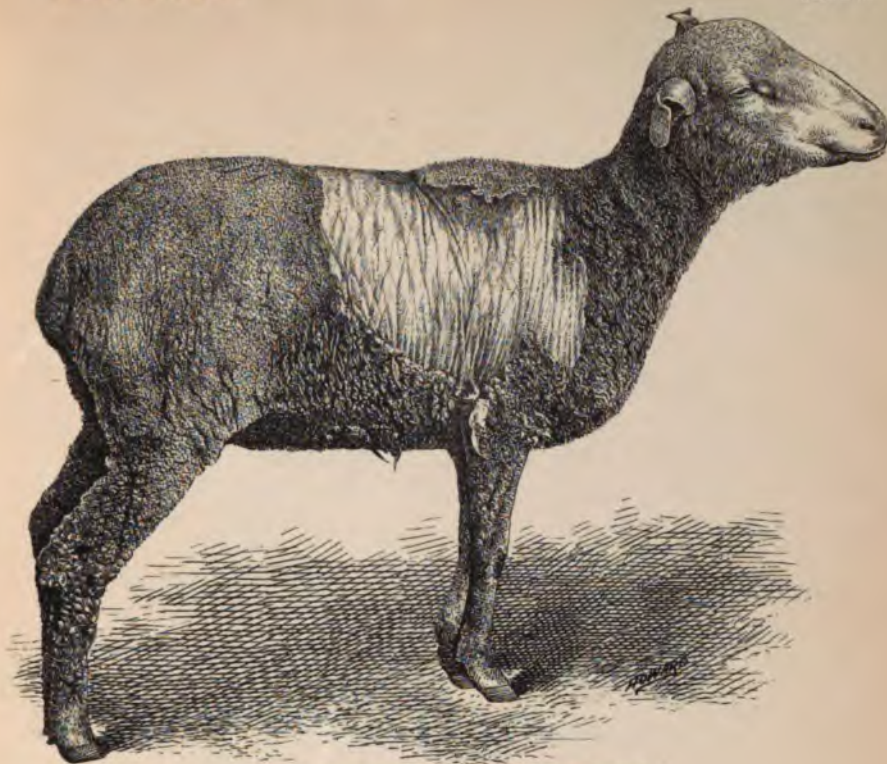


FIG. 3. A SHORN SHEEP WITH LARGE BARE AREA DUE TO SCAB.

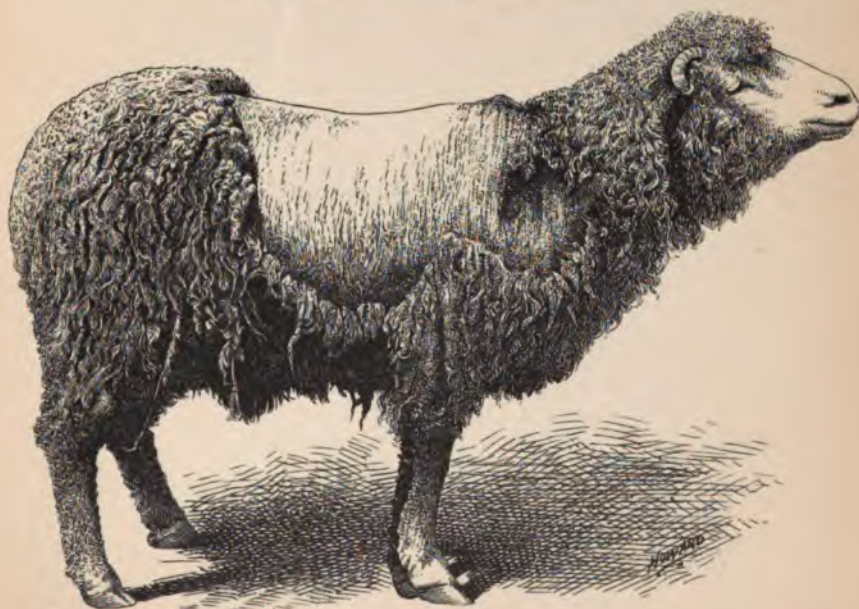


FIG. 4. AN ADVANCED CASE OF COMMON SCAB.



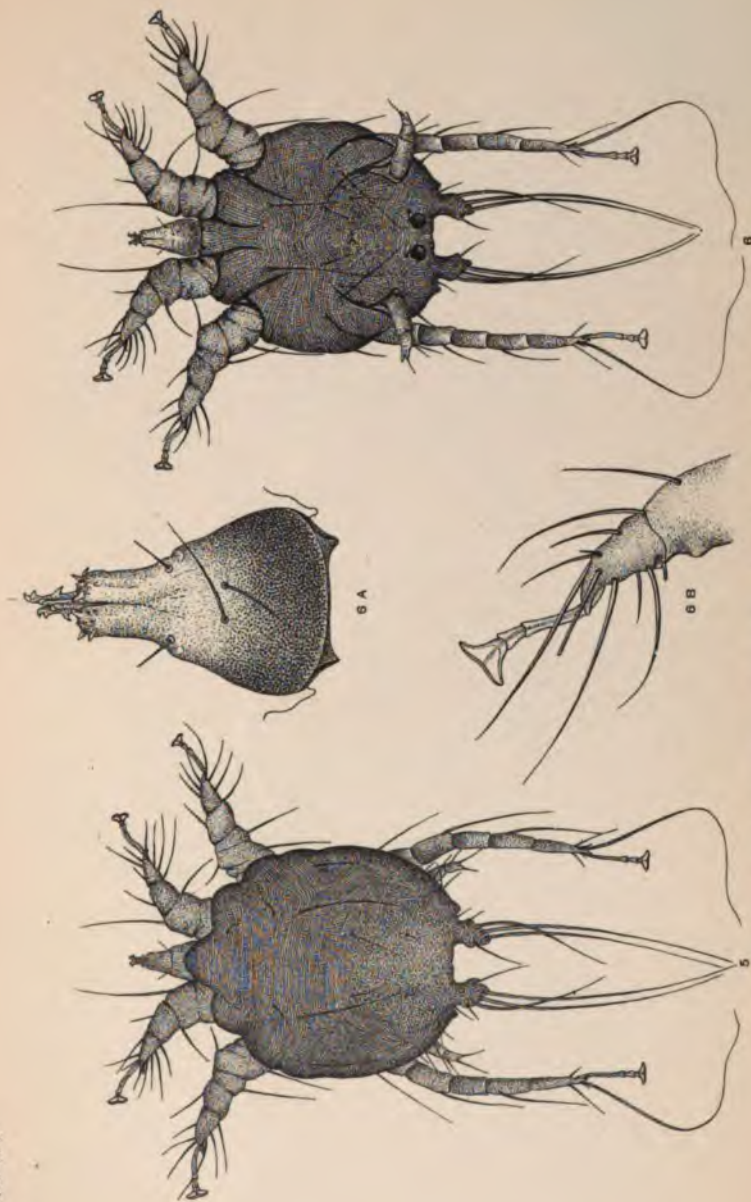


FIG. 5. ADULT MALE PARASITE OF COMMON SHEEP SCAB, DORSAL VIEW. FIG. 6. VENTRAL VIEW OF SAME. FIG. 6 A. HEAD OF FEMALE. 6 B. LEG OF FEMALE. ALL GREATLY ENLARGED.



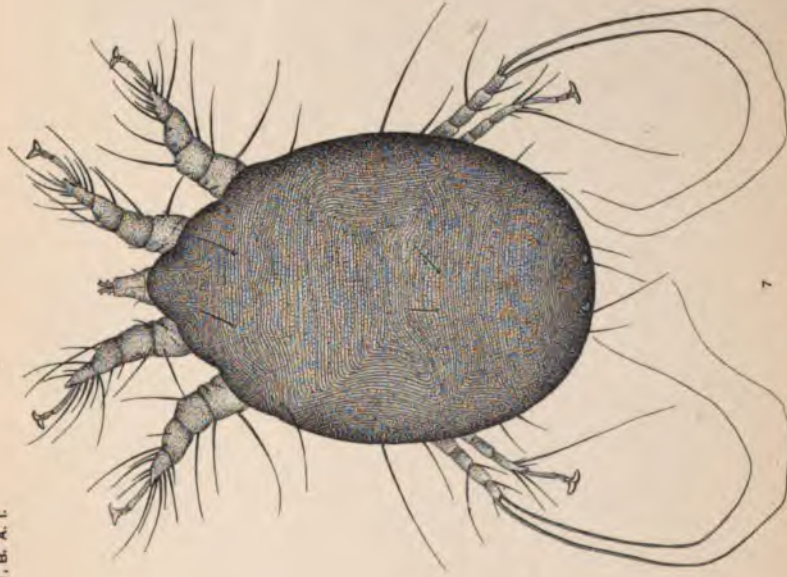


FIG. 7. ADULT FEMALE PARASITE OF COMMON SHEEP SCAB, DORSAL VIEW.

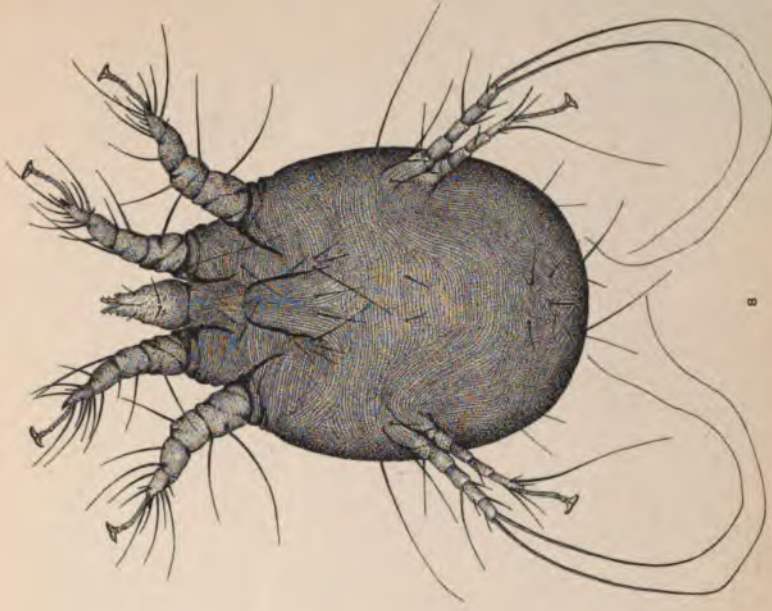


FIG. 8. VENTRAL VIEW OF SAME.

BOTH GREATLY ENLARGED.

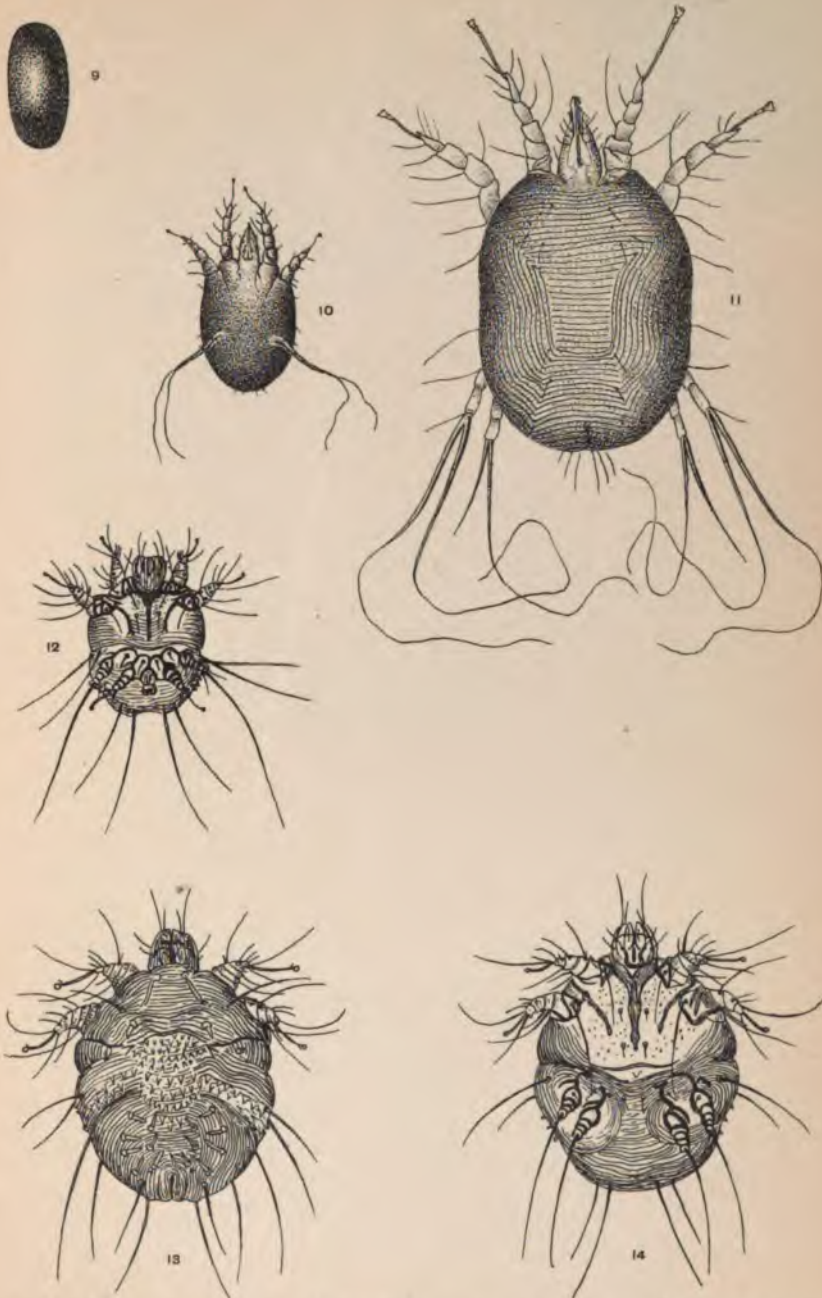


FIG. 9. EGG OF MITE WHICH CAUSES COMMON SHEEP SCAB. FIG. 10. SIX-LEGGED STAGE OF SHEEP SCAB MITE. FIG. 11. YOUNG FEMALE BEFORE MOULTING FOR THE LAST TIME, DORSAL VIEW. FIG. 12. ADULT MALE PARASITE OF SARCOPTIC SCABIES OF MAN (THE CORRESPONDING PARASITE OF SHEEP IS VERY SIMILAR), VENTRAL VIEW, X 250 (AFTER BLANCHARD). FIG. 13. ADULT FEMALE PARASITE OF SARCOPTIC SCABIES, DORSAL VIEW, X 250 (AFTER BLANCHARD). FIG. 14. SAME, VENTRAL VIEW (AFTER BLANCHARD). ALL GREATLY ENLARGED.



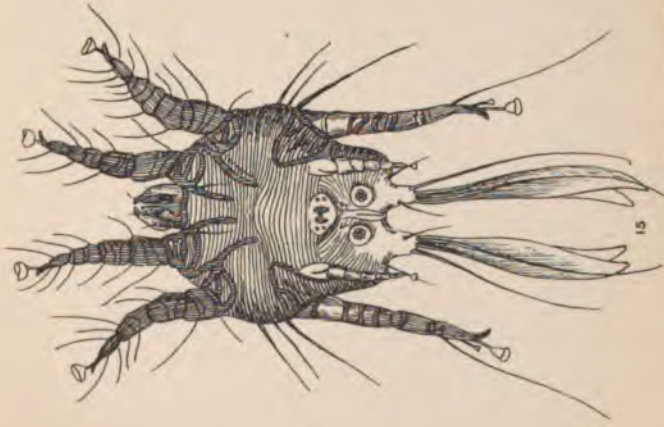


FIG. 15.

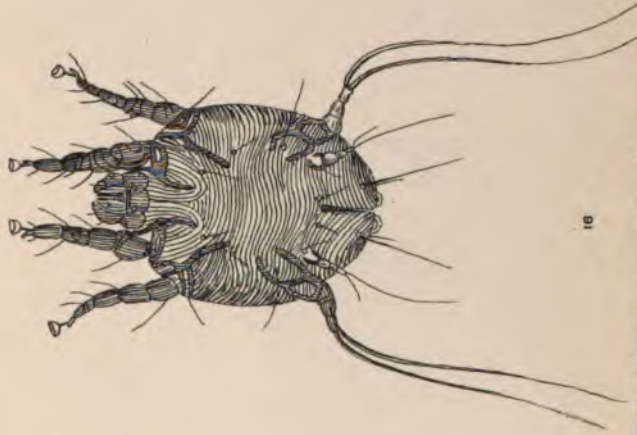


FIG. 16.

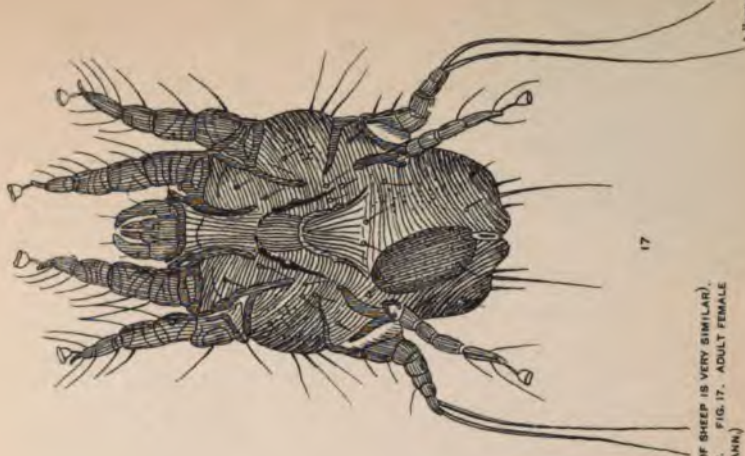


FIG. 17.

ADULT MALE PARASITE OF CHORIOPTIC SCABIES OF THE HORSE (THE CORRESPONDING PARASITE OF SHEEP IS VERY SIMILAR).
VENTRAL VIEW. FIG. 16. YOUNG FEMALE PARASITE OF CHORIOPTIC SCABIES, VENTRAL VIEW.
PARASITE OF CHORIOPTIC SCABIES WITH EGGS, VENTRAL VIEW. (ALL X 100, AFTER NEUMANN.)



scabiei var. *ovis*.¹ The second is the symbiotic scab (foot scab), which affects the limbs, scrotum, and udder, and is caused by the *Chorioptes communis* var. *ovis*.² Lastly may be mentioned an extremely rare affection, the so-called follicular, or demodectic, scab, affecting the eyelids, caused by a mite known as *Demodex folliculorum* var. *ovis*.³

The sarcoptic, symbiotic, and demodectic forms of scab are with sheep mild diseases compared with common scab, and appear to be rather rare.

DESCRIPTION OF SHEEP SCAB.

(1) COMMON SCAB, BODY SCAB, OR PSOROPTIC SCAB.

Although the symptoms of common scab are familiar to most farmers, they will here be briefly reviewed.

The mites of common, or body, scab—that is, the *Psoroptes*—prick the skin of the animal to obtain their food, and probably insert a poisonous saliva in the wound. Their bites are followed by intense itching, with irritation, formation of papules, inflammation, exudation of serum, and the formation of crusts, or scabs, under and near the edge of which the parasites live. As the parasites multiply they seek the more healthy parts, spreading from the edges of the scab already formed, thus extending the disease. The sheep are restless; they scratch and bite themselves, and rub against posts, fences, stones, or against other members of the flock. This irritation is particularly noticeable after the animals have been driven, for the itching is more intense when the sheep become heated. The changes in the skin naturally result in a falling of the wool; at first slender “tags” are noticed; the fleece assumes the condition known as “flowering;” it looks tufty or matted, and the sheep pulls out portions with its mouth, or leaves tags on the objects against which it rubs. Scabs fall and are replaced by thicker and more adherent crusts. The skin finally becomes more or less bare, parchment-like, greatly thickened, furrowed, and bleeding in the cracks. With shorn sheep especially a thick, dry, parchment-like crust covers the greatly tumified skin. Ewes may abort or bear weak lambs.

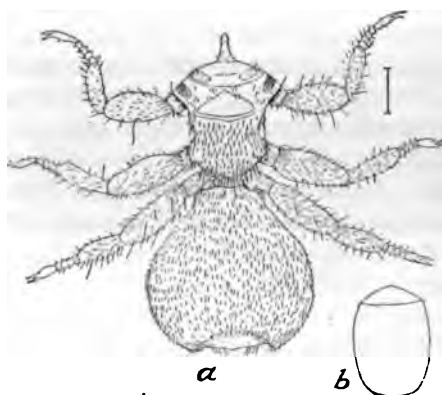


FIG. 2.—Adult sheep tick (a) and puparium (b) (*Melophagus ovinus*). Enlarged. (After Osborn, 1896; Bul. No. 5, Div. Entomology, Dept. Agr.)

¹ *Sarcoptes*, from the Greek, means that the mites wound the flesh.

² *Chorioptes* signifies that the mites hide in the skin. Another name, *Symbiotes*, signifies that a number of the mites live together; and a third name, *Dermatophagus*, means that the mites eat the skin.

³ *Demodex* signifies that the mites have a worm-like body.

Parts of body affected.—When sheep are kept in large numbers the chances for infection are naturally greater, and the disease may begin on almost any part of the body. Generally, however, it affects the parts which are covered with wool. When the sheep are fat and the wool has a large amount of yolk, the progress of the disease may be slow; usually beginning on the upper part of the body, withers, and back, it extends slowly, but none the less surely and in ever-increasing areas, to the neck, sides, flanks, rump, etc. In two or three months the entire body may be affected.

Contagion.—Common scab is exceedingly contagious from one sheep to another, and may in some cases show itself within about a week after healthy sheep have been exposed to infection. The contagion may be direct, by contact of one sheep with another; or indirect, from tags of wool, or from fences, posts, etc., against which scabby sheep have rubbed, or from the places where the sheep have been "bedded down." One attack of scab does not protect sheep from later attacks. Transmitted to man, sheep scab may produce a slight spot on the skin, a point which is sometimes taken advantage of for the purpose of diagnosis. In case of suspected scab, one of the crusts is bound lightly on the arm. After a short time an itching sensation is felt and the mites are found on the skin. Transmitted to horses, cattle, or goats, common sheep scab fails to develop.

Chances for recovery.—Cases of apparent spontaneous recovery are rare. Usually when proper methods of treatment are not adopted the disease increases, leads to anæmia, emaciation, exhaustion, and death, and may result in a loss of from 10 to 80 per cent of the flock. Scab is favored by seasons when the wool is longest, and by huddling or overcrowding the animals; also race, energy, temperament, age, state of health, length, fineness, and abundance of wool, and the hygienic conditions of the surroundings influence the course and termination of the disease. Young, weak, closely inbred animals, and those with long, coarse wool will most quickly succumb. Unhealthy localities, damp climate, and poorly ventilated sheds favor the disease. Pure or mixed Merino sheep succumb sooner than certain other breeds. The mortality varies according to conditions, but is highest in autumn and winter. When owners are careless the death rate may be very high; if untreated the sheep may die in two to three months. Hygienic conditions, good food, and cool dry atmosphere tend to check the disease. Sheep sheds should accordingly be well ventilated and open to light and sunshine. With proper attention to hygienic conditions and thorough dipping, a positive cure can be guaranteed.

Vitality of the parasite.—Taken from the sheep, the mites possess a remarkable vitality. It is generally stated that, kept at a moderate temperature on portions of scab, the adults may live from four to twenty days, but they will occasionally live much longer; cases are on record where they have lived three, four, or even six weeks when sepa-

rated from sheep; if the atmosphere is dry they will generally die in about fifteen days; but death is often only apparent, for the mites may sometimes be revived by warmth and moisture even after six or eight weeks; the fecundated females are especially tenacious of life. Various rather contradictory statements may be found regarding their resistance to cold: Krogmann states that they may live at a temperature of minus 10° C. ($+14^{\circ}$ F.) for twenty-eight days; other authors claim that the mites die in two hours at 47° F.; still other authors, that they die at 50° C. (122° F.). They are said to have been kept alive in cold water for six days and in warm water for ten days. Several authors admit, however, that the parasites are usually killed by a soaking rain; though it is claimed that in damp, dark stables they "may live for months."

Experience has shown that in some cases apparently healthy sheep have become infected in places where no sheep have been kept for four, eight, twelve, or even twenty-four months. The conditions underlying this infection are not thoroughly understood. Possibly some of the eggs have retained their vitality a long time and then hatched out; possibly the vitality of the fecundated female has also played a rôle; while it is not at all improbable that an entirely new infection has accidentally been introduced by birds or other animals. Certain authors of high standing scout the idea that birds can introduce an infection of scab, but there is no reason why birds should not do this, and there are some reasons for believing that they do. It has been noticed on the Experiment Station of the Bureau, for instance, that crows delight in perching on the backs of scabby sheep and picking at the scab; while so doing it is only natural that small tags of wool would adhere to their feet, and thus scatter scab. The fact that snails cling to birds' feet and are carried long distances is too well established to need discussion, and it is very probable that many of the cases where sheep are supposed to have become infected with scab on pastures which have not been occupied for one or two years are in reality cases of fresh infection by means of birds. From the data at hand, while it may be admitted that in some cases, under favorable conditions, the mites may live from spring to fall, it is scarcely within the limits of probability that either the scab mites or their eggs will live through a winter when separated from the sheep and exposed to the elements.

All matters connected with the vitality of the scab mite have an important bearing in explaining cases of indirect infection on roads over which scabby sheep have been driven, or in fields and sheds where they have been kept. From the facts now at our disposal we can lay down the following important rules:

(1) Scabby sheep should never be driven upon a public road; (2) sheds in which scabby sheep have been kept should be thoroughly cleaned, disinfected, and aired, and should be left unused for *at least four weeks* (better two months) before clean sheep are placed in them;

ing may become difficult because of the formation of crusts around the mouth and nostrils. Small papules form, with soft centers; usually the rubbing causes them to break, and they exude a fluid which hardens and forms a scab; the scabs, increasing in number, may run together; they become thicker and harder, until almost the entire head is merged into one crust. Rubbing causes the crusts to break; the wounds heal and form scars; the skin thickens and is raised in folds, in which cracks appear and from which there may be bleeding. When affecting lambs the disease may assume an ulcerative character.

Parts of body affected.—This form of scab appears on parts of the body where the wool is scarce; usually beginning about the nostrils

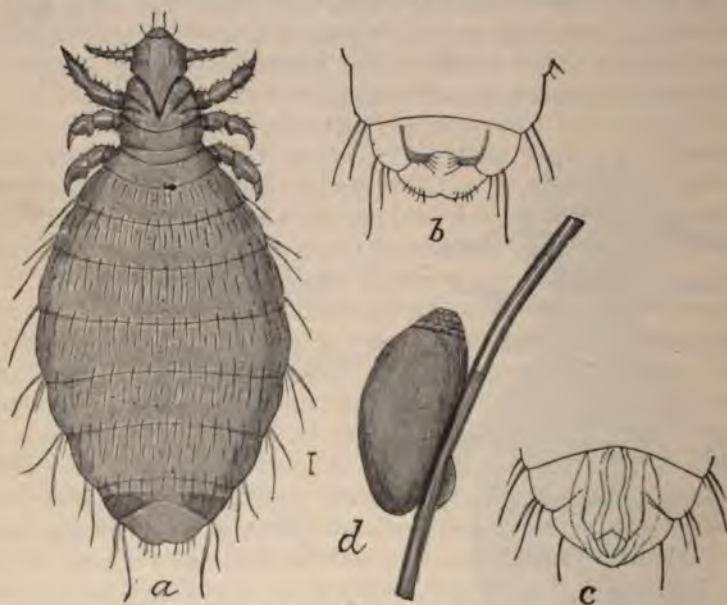


FIG. 4.—Sheep foot louse (*Hormatopinus pedalis*): a, adult female; b, ventral view of terminal segment of same, showing brushes; c, terminal segments of male; d, egg. Enlarged. (After Osborn, 1896; Bul. No. 5, Div. Entomology, Dept. Agr.)

and on the upper lip, more rarely about the eyes and ears, it spreads to the cheeks, eyes, forehead, and under the jaws; in severe cases it may extend to the belly, front legs, knees, hocks, and pasterns. Coarse dry wool favors it more than fine oily wool. The line between the diseased and the healthy skin is quite sharply defined.

Contagion.—Head scab is contagious from sheep to sheep, from sheep to goats, and rarely from sheep to man; when transmitted from sheep to horses, cattle, and dogs the disease remains local and does not spread. Head scab is also contagious from goats to sheep. Viborg states that the sarcoptic scab of pigs is contagious to sheep, but this is denied by Am-Pach. Chabert maintained that sarcoptic scab of dogs is transmissible to sheep, but this is doubtful.

Chances for recovery.—Head scab can be easily treated if taken in time, but if neglected it will cause inflammation of the eyes and extensive alterations in the skin, and will prevent the sheep from fattening.

(3) FOOT SCAB, OR CHORIOPTIC SCAB.

Foot scab is rare, if present at all, in this country, but a number of cases have recently been reported from England. It is not impossible that some of the cases supposed to be foot rot are in reality foot scab.

The minute parasites, which are much smaller than those of common scab, cause an intense itching, which leads the sheep to stamp their feet and scratch and bite the infected parts. There is a reddening of the skin, followed by scaling, and later by the formation of yellowish white crusts; the crusts thicken, cracks may form in the folds of the pasterns, and the legs may become quite unsightly.

Parts of the body affected.—The disease appears on the feet and legs, spreading slowly to the upper parts of the legs and the adjoining parts of the body, scrotum, or udder.

Contagion.—This disease is contagious from sheep to sheep, but not so actively as common scab.

(4) FOLLICULAR SCAB, OR DEMODECTIC SCAB.

The glands of a sheep's eyelids are occasionally infected with a fourth kind of microscopic mite, which is elongate and much like a worm. It has been recorded but a few times, and for the present, at least, is of no importance to the American sheep raiser.

CONDITIONS WHICH MAY BE MISTAKEN FOR SCAB.

Any parasite or condition which causes an itching, and thus leads the sheep to scratch themselves, or any abnormal condition of the skin, may be temporarily mistaken for scab; but if the rule is held in mind that no scab is possible without the presence of the specific parasites, it will be easily determined whether scab is present or not. The following are the more important cases to be considered:

(1) *Itching due to other parasites*, such as the common "sheep tick," true ticks, and lice, may be distinguished from scab by finding the parasites. The dipping used for treating scab will also kill sheep ticks and lice.

(2) *Inflammation of the sebaceous glands.*—This may be mistaken for common scab. It appears most frequently in autumn. There is a severe itching, the skin is red and sensitive, and is covered with a strong-smelling, yellowish, viscid yolk; tufts of wool may be shed. It may be cured, after shearing, with any starchy lotion.

(3) *Rain rot.*—In rainy weather an eruption may appear on the skin which might be mistaken for scab. There is, however, no parasite present; itching is absent, and the trouble disappears when dry weather comes.

THE TREATMENT OF SCAB.

In the foregoing discussion attention has been called to the necessity of keeping sheep under proper hygienic conditions. That alone, though of importance in connection with the subject of treatment, can not be relied upon to cure scab. The only rational treatment consists in using some external application which will kill the parasites. Formerly medicines were given internally, and even within a few years past it has been claimed that feeding sulphur to sheep will cure the disease. The statements regarding sulphur were such as to lead us to try the experiment, which, however, was soon abandoned as unsuccessful. The external application of scab cures is in various ways made known as hand dressing, hand curing, spotting, pouring, smearing, and dipping. Of these methods, dipping is by far the most satisfactory.

HAND APPLICATIONS.

In case of head scab, or in light cases of foot scab, hand applications may be resorted to, and will frequently suffice. A nonpoisonous ointment may be made by taking 4 ounces of oil of turpentine, 6 ounces of flowers of sulphur, and 1 pound of lard. Mix the ingredients at a gentle heat, and rub in well with the hands or with a brush, at the same time breaking the crusts. The simple sulphur ointment may be made of 1 part of sulphur and 4 parts of lard; one-fourth part of mercurial ointment may be added. Few remedies are so useful in mange in dogs, ringworm, and other itching complaints as sulphur iodide, and it may well be given a trial on head scab. It is prepared as follows: Mix in a nonmetallic vessel, as a porcelain mortar, 4 ounces of iodine with 1 ounce of sublimed sulphur, gently heating the mixture until it liquefies; the red-brown liquid upon cooling becomes a gray-black crystalline mass, insoluble in water, but soluble in glycerine and fats, with 8 or 10 parts of which it is mixed for ointments or liniments. An ointment of flowers of sulphur and carbolated vaseline would also probably give good results. One author advises for head scab and foot scab a mixture consisting of 1 part of mercurial ointment and 11 parts of sulphur ointment. Foot scab and head scab would also probably respond to treatment with the various dips used for common scab.

Hand dressing is not recommended for common scab; in fact, it must be looked upon as directly responsible for a considerable amount of the disease, since it is too often relied upon to cure the disease, while in reality it is only a palliative. The only condition under which hand dressings can be advised is in case scab is discovered in one or two sheep of a flock during severe winter weather, when dipping would be impracticable. In that event, the infected sheep should be immediately isolated from the flock; and they might be hand dressed, if desired, in order to hold the disease in check. It can not be too strongly insisted upon that "pouring," "spotting," etc., are only expensive and temporizing methods of dealing with scab.

"Pouring" is done as follows: Part the wool on the back by making a furrow with the finger from the head to the tail; furrows are also made along the shoulders and thighs to the legs, and on the sides; pour the ointment or dip in these furrows. A still better plan is to pour the warm dip from a coffeepot or teapot directly on the affected parts, rubbing it well in with the hand, a brush, or a corncob. It must be repeated for emphasis, however, that such treatment can not be relied upon, and should be used only in emergency cases when dipping is impracticable.

A mercurial ointment may be made as follows: (A) dissolve 1 pound of resin in one-half pint of oil of turpentine; (B) mix 1 pound of mercurial ointment with 6 pounds of lard, with gentle heat, and (C) when cool mix the two compounds, A and B. It should be remembered that mercurial ointments are not unattended with danger, and on this account it is better to prepare a small amount of dip and pour it on the affected part as described above.

DIPPING.

By far the most rational and satisfactory, and the cheapest method of curing scab is by dipping the sheep in some liquid which will kill the parasites. The dipping process is as follows:

(1) Select a dip containing sulphur. If a prepared "dip" is used which does not contain sulphur, it is always safer to add about 16½ pounds of sifted flowers of sulphur to every 100 gallons of water, especially if, after dipping, the sheep have to be returned to the old pastures.

(2) Shear all the sheep at one time, and immediately after shearing confine them to one-half the farm for two to four weeks. Many persons prefer to dip immediately after shearing.

(3) At the end of this time dip every sheep (and every goat also, if there are any on the farm).

(4) Ten days later dip the entire flock a second time.

(5) After the second dipping, place the flock on the portion of the farm from which they have been excluded during the previous four or five weeks.

(6) Use the dip at a temperature of 100° to 110° F.

(7) Keep each sheep in the dip for two minutes by the watch—do not guess at the time—and duck its head at least once.

(8) Be careful in dipping rams, as they are more likely to be overcome in the dip than are the ewes.

(9) Injury may, however, result to pregnant ewes, which must, on this account, be carefully handled. Some farmers arrange a stage, with sides, to hold the pregnant ewes, which is lowered carefully into the vat, and raised after the proper time.

(10) In case a patent or proprietary dip, especially an arsenical dip, is used, the directions given on the package should be carried out to the letter.

CHOICE OF A PREPARATION FOR DIPPING.

Numerous different sheep dips are recommended by various parties, and undoubtedly many of them are efficacious; few dips can be named which some persons do not consider far superior, and other persons consider far inferior to all other dips known; few dips can be found which have not cured cases of scab, and probably no dip can be named with which failures have not been reported. Under these circumstances the farmer should not be deceived by exaggerated statements in either extreme; he should recall that it lies in the business interest of the manufacturers of every proprietary, or patent, dip to advertise their own particular dip in every way possible, but that too often these merchants pursue the method of deprecating the use of homemade dips as "dangerous," "ineffective," "liable to produce blood poisoning," etc., and of citing the accidents, failures, and dangers of other proprietary dips rather than of giving exact and reliable statements regarding the successes of their own compounds.

PROPRIETARY ARTICLES.

The Department can not properly advertise or recommend the use of any dip which is made from a secret formula. It can not be said that no such dip has any value as a scab cure, or that such dips have never met with any success, for that would be a misrepresentation of facts. The farmer should, however, know the composition of the material he is using. If he desires to use a ready-made dip, let him inform himself of the exact nature of that dip in order to prevent impositions and guard against dangers. He would do well to refuse to purchase any prepared dip which does not bear on each package a printed statement of the ingredients and their proportions, which the manufacturer guarantees are to be found in that package; he would also do well to avoid any dip which irresponsible parties advertise as "the only sure cure for scab," etc. Proprietors thus advertising are either showing gross ignorance of the history and nature of scab, and hence are not to be taken as advisers, or they are intentionally misrepresenting established facts.

In case of more than one proprietary dip, it seems quite clear from the circulars and advertisements distributed by the manufacturers that the firms have had little or no practical experience with scab, and that the extravagant claims set forth by them for their mixtures are little less than artful methods of advertising, rather than statements based upon any tests or experiments. Good examples of worthless or almost worthless dips are cited by Bruce, who quotes the treatment of 80,021 cases of scab with *Allen's Specific*, with not a single case of cure! *Hayes's Specific* cured 6,255 cases and failed in 80,931 cases!

SUCCESS WITH HOMEMADE DIPS.

While a dip should not be condemned simply because it is prepared ready for use—for it may be frankly admitted that there are some excel-

lent proprietary dips—the value of homemade dips must be insisted upon, and attention is called to the fact that it was almost entirely through homemade dips that scab was eradicated from certain of the Australian colonies, and that year after year, in the reports of the scab inspectors of Capetown Colony, the first and third places are accorded to homemade dips, while second place is accorded (with some qualification) to a secret dip. In this connection the following significant remarks, made in 1892 by the chief inspector of stock in Queensland, will be of interest:

Our Australian experience of tobacco and sulphur and of lime and sulphur as the only effectual means of curing scab is such that at the stock conference held in Sydney in 1886, and again in Melbourne in 1889, attended by the chief and Government veterinarians of all the colonies, it was on both occasions decided that none but these two dips be recognized in the colonies, and this has now been embodied in regulations under the "Stock disease acts" of all the colonies.

The stamping out of scab in these colonies has been more retarded by vendors of patent dips than by any other cause; hence the determination of the governments of all the colonies to forbid the use of any specific except tobacco and sulphur or lime and sulphur for scab or for the (precautionary) dressing of imported sheep while in quarantine.

In view of the more or less frequent statements that scab was eradicated from the English colonies by killing the scabby sheep or by the use of prepared dips it may be well to say that these statements are erroneous. "It is true an act was passed in New South Wales about 1851 compelling the slaughter of scabbed sheep, and a few remaining straggling flocks were destroyed under that act, but later, on the reappearance of scab in that colony in 1863 by infection from Victoria, the act was repealed, and the whole of the scabbed sheep, about 400,000, were completely cured by means of tobacco and sulphur."¹

IMPORTANCE OF PROPER USE OF DIP.

Whatever dip is selected, the farmer should not forget that there are two ways to use that dip. One way is to prepare and use it in accordance with the directions given; the other way is to attempt to economize time, labor, or money by using the dip in weaker proportion than advised, by hurrying the sheep through the swim, or by later placing the dipped sheep under unfavorable conditions. If the former method is adopted with any of the established dips, the treatment ought to be followed with favorable results; if the latter method is adopted, the farmer himself must assume the responsibility of failure, no matter which dip he decides to use. Every farmer should therefore remember that when he has decided upon the dip he is to use his work has only begun; to use the dip properly is fully as important as to use a dip at all.

¹ Statement made by P. A. Gordon, chief inspector of stock, Queensland.

PRELIMINARY QUESTIONS IN CHOOSING A DIP.

The homemade dips which are most commonly used have either tobacco or sulphur as their basis, while the prepared dips contain tobacco, sulphur, arsenic, carbolic acid, etc., as curative agents.

In selecting a dip several points should be considered: First of all, the question of expense will naturally arise; next, the question as to whether or not scab actually exists in the flock to be dipped, or whether or not the dipping is more of a precautionary matter, or for the sake of cleansing the animal's skin. The facilities at hand, the setback to the sheep, and the length of the wool are also matters for consideration, as well as the pastures into which the dipped sheep are to be placed. Notwithstanding statements to the effect that a given dip can be used under all conditions, the above questions are evidently important.

Expense.—In estimating the expense one should consider not only the actual outlay for the ingredients of the ooze, but the cost of fuel and labor, the injury, if any, to the sheep, and the liability of not curing the disease. It is much more economical to use an expensive dip and cure scab than it is to use a cheap dip and fail to cure it. To illustrate with a well-known homemade dip: A lime-and-sulphur dip may be made in ten to thirty minutes, with but little fuel and little labor, which may or may not cure the disease, and which will surely do great injury to the wool; or a lime-and-sulphur dip may be made in several hours' time, at the expense of considerable fuel, labor, and patience, which can be relied upon to cure scab, and which will do little or no injury to the wool. The first dip is cheap, but not economical; the second dip is more expensive, but more economical.

Does scab exist in the flock?—Every farmer should ask himself this question before he selects his dip. If scab does not actually exist and the wool is long, the dipping in this case simply being a matter of precaution, it is best not to select a dip containing lime. The use of the lime-and-sulphur dips is therefore not advised simply as precautionary dressing for healthy long-wooled sheep. On the contrary, the use of any dip containing lime, as a precautionary measure, should be avoided.

The facilities at hand for preparing dip.—If fuel is very scarce, so that it is impracticable to boil the mixture for at least two hours, the lime-and-sulphur dips should not be selected. A tobacco-and-sulphur dip, as well as many of the better proprietary dips, can be made without the necessity of lengthy boiling, and should be given preference whenever facilities for boiling are not at hand.

The length of the wool.—See remarks upon this subject in discussion of lime and sulphur, page 26.

The pastures.—In case it is necessary to place the dipped sheep on the same pastures they occupied before being dipped, it is always best to use a dip containing sulphur. If a proprietary dip is selected under those circumstances, it is suggested that sulphur be added, about 1 pound of flowers of sulphur to every 6 gallons of dip. In case it is

possible to utilize fresh pastures after dipping, the use of sulphur is not so necessary, but is always advisable. The object in using sulphur is to place in the wool a material which will not evaporate quickly, but will remain there for a longer period of time than the scab parasites ordinarily remain alive away from their hosts. By doing this the sheep are protected against reinfection.

KINDS OF DIPS.

Sulphur is one of the oldest known remedies for scab, its use dating back to Columella in the early part of the Christian era. As a scab eradicator, it must be placed among the best substances at our disposal. It is one of the constituents of certain proprietary dips, but its use to the farmer is best known in the tobacco-and-sulphur dip and in the lime-and-sulphur dip. These homemade mixtures are the two dips which have played the most important rôles in the eradication of scab from certain English colonies, and their use, especially the use *as well as the abuse* of lime and sulphur, is quite extensive in this country.

THE TOBACCO-AND-SULPHUR DIP.

The formula, as given here and as adopted by the New South Wales sanitary authorities, appears to have first been proposed in 1854 by Mr. John Rutherford. Regarding its success in Australia, Dr. Bruce, chief inspector of sheep for New South Wales, makes the following statements:

On the Hopkins Hill Station Mr. Rutherford, with two dressings of these ingredients, then cured over 52,000 sheep which had been infected for eighteen months; and he also subsequently cured with two dippings the sheep on Mount Fyans Station, where they were in a most wretched state, and had been scabby for more than three years, and that, too, in both cases, without destroying a single hurdle or yard or removing any of the sheep from their old runs.

Since then millions of scabby sheep have been permanently cured in Victoria in the same way, and in South Australia and New South Wales hundreds of thousands of scabby sheep have also been cleansed with tobacco and sulphur. In fact, this dressing has the credit of having eradicated scab from the flocks of both the latter colonies, and there are good grounds for asserting that had this remedy not been known and used neither colony would be, as they both are now, almost entirely free from the scourge. Judging therefore from the experience of the three colonies, there is no medicament or specific yet known [1884] that can be compared with tobacco and sulphur as a thorough and lasting cure for scab in sheep.

The proportions adopted by Rutherford, and afterwards made official by the scab sanitary authorities, are:

Tobacco leaves.....	pound..	1
Flowers of sulphur.....	do....	1
Water.....	gallons..	16

The advantage of this dip lies in the fact that two of the best scab remedies, namely, tobacco (nicotine) and sulphur, are used together,

¹ The original formula reads 5 gallons (imperial) which are equivalent to 6 United States gallons.

both of which kill the parasites, while the sulphur remains in the wool and protects for sometime against reinfection. As no caustic is used to soften the scab, heat must be relied on to penetrate the crusts.

Directions for preparing the dip.—A. Infusing the tobacco: Place 1 pound of good leaf or manufactured tobacco for every 6 gallons of dip desired in a covered boiler of cold or lukewarm water and allow to stand for about twenty-four hours; on the evening before dipping bring the water to near the boiling point (212° F.) for an instant, then remove the fire and allow the infusion to stand over night.

B. Thoroughly mix the sulphur (1 pound to every 6 gallons of dip desired) with the hand in a bucket of water to the consistency of gruel.

C. When ready to dip, thoroughly strain the tobacco infusion (A) from the leaves by pressure, mix the liquid with the sulphur gruel (B), add enough water to make the required amount of dip and thoroughly stir the entire mixture.

All things considered, the tobacco-and-sulphur is as good a dip as is known at the present time.

See also the discussion of the tobacco dip on page 30.

LIME-AND-SULPHUR DIPS.

Under the term "lime-and-sulphur dips" is included a large number of different formulæ requiring lime and sulphur in different proportions. In general practice all of these dips are spoken of as "the lime-and-sulphur dip," but in reality each separate formula represents a separate dip.

To give an idea of the variety of the lime-and-sulphur dips, the following list is quoted, the ingredients being reduced in all cases to avoirdupois pounds and United States gallons:

1. The original "Victorian lime-and-sulphur dip" proposed by Dr. Rowe, adopted as official in Australia:

Flowers of sulphur	pounds..	20½
Fresh slaked lime	do.....	10½
Water	gallons..	100

2. South African (Cape Town) official lime-and-sulphur dip:

Flowers of sulphur (minimum)	pounds..	15
Unslaked lime	do.....	15
Water	gallons..	100

3. South African (Cape Town) official lime-and-sulphur dip, February 4, 1897:

Flowers of sulphur	pounds..	20½
Unslaked lime	do.....	16½
Water	gallons..	100

4. Nevada lime-and-sulphur dip:

Flowers of sulphur	pounds..	16½
Lime	do.....	33½
Water	gallons..	100

5. Fort Collins lime-and-sulphur dip:

Flowers of sulphur	pounds..	33
Unslaked lime.....	do.....	11
Water	gallons..	100

6. A mixture which, used to some extent by this Bureau, contains the same proportions of lime and sulphur (namely, 1 to 3) as the Fort Collins dip, but the quantities are reduced to:

Flowers of sulphur	pounds..	24
Unslaked lime.....	do.....	8
Water	gallons..	100

Dangerous formulæ.

7. California lime-and-sulphur dip:

Flowers of sulphur	pounds..	100
Lime.....	do.....	25
Water	gallons..	100

8. A very dangerous misprinted formula to be found in several books and journals, probably due to a typographical error:

Flowers of sulphur	pounds..	100
Lime.....	do.....	150
Water	gallons..	100

In case of fresh scab formula No. 6 will act as efficaciously as the dips with a greater amount of lime, but in cases of very hard scab a stronger dip, as the Fort Collins dip, should be preferred, or, in unusually severe cases, an ooze with more lime in proportion to the amount of sulphur, such as the Victorian (No. 1), the Nevada (No. 4), or the South African (No. 3) dip might be used.

Many other formulæ might be cited, but these are enough to show the great variations in the dips which have been used; and to prove that when a party simply states that "lime and sulphur" is an excellent dip, or that it is a dangerous dip, or that he has succeeded or failed with it, or that the lime-and-sulphur dip is injurious to the wool, his statements can not be taken as definite, unless he also states which lime-and-sulphur dip he used and how he used it.

Prejudice against lime-and-sulphur dips.

There is at present great prejudice (a certain amount of it justified no doubt) against the use of lime and sulphur, emanating chiefly from the agents of patent or proprietary dips and from the wool manufacturers. It will be well therefore to consider the points brought forward by them against its use.

In the first place, it is frequently asserted that lime and sulphur does not cure scab. This statement is, of course, in the interest of proprietary dips, but it is based either upon an absolute ignorance or a misrepresentation of facts. Experience in Australia and South Africa, as well as in this country, has shown beyond any doubt that a lime-and-sulphur dip, when properly proportioned, properly prepared, and properly used, is one of the best scab eradicators known. Cases of its

failure have been due to careless or improper methods of its preparation and use.

It is claimed by some that it produces "blood-poisoning." But the cases of death following the use of lime-and-sulphur dips have been infinitesimally few when compared with the number of sheep dipped in these solutions and when compared with the deaths which have been known to follow the use of certain proprietary dips. The details of such accidents so far as they have been reported have not shown that death was due to any properly prepared and properly used lime and-sulphur dip. If the formula of 100 pounds of sulphur, 150 pounds of lime, and 100 gallons of water has killed animals, that surely is no argument against the formula 33 pounds of sulphur, 11 pounds of lime, and 100 gallons of water, but simply shows that the former formula is too strong; if any other conclusion than this is drawn, consistency would compel us to reject many of our most valuable remedies because some parties had used them in overdose. The argument frequently raised against lime and sulphur—namely, that "shear-cut" sheep die when dipped immediately after shearing in a lime-and-sulphur dip which has stood for some time—can be used equally well against other dips, and simply shows that it is safer to use a fresh supply of dip and to allow a short time to elapse after shearing before dipping. It is highly probable that the cases of so-called "blood-poisoning" of shear-cut sheep are generally due to an infection with bacteria in stale dip containing putrefying material. Some cases of death are also said to have occurred after using a lime-and-sulphur dip made in brass kettles.

In an experiment by this Bureau, 5 cc. of a clear lime-and-sulphur ooze (Formula No. 6) has been injected under the skin of a sheep without producing any evil effects.

The greatest objection raised against the use of lime-and-sulphur dip is that it injures the wool. This objection is raised by many wool manufacturers, and echoed with ever-increasing emphasis by the manufacturers of prepared dips; while, after years of extensive experience with properly prepared dip, its injury to the wool is strongly and steadfastly denied by the agricultural department of Cape Colony.

It is believed that a certain amount of justice is attached to this objection to lime and sulphur as generally used; unless, therefore, lime and sulphur can be used in a way which will not injure the wool to an appreciable extent, we should advise against its use in certain cases; in certain other cases the good accomplished far outweighs the injury it does. Let us, therefore, examine into this damage and its causes.

The usual time for dipping sheep is shortly after shearing, when the wool is very short; whatever the damage at this time, then, it can be only slight, and the small amount of lime left in the wool will surely do but little harm.

In full fleece, lime and sulphur will cause more injury. In Australia the deterioration was computed by wool buyers at 17 per cent, although in Cape Colony the department of agriculture maintains that if prop-

erly prepared, and if only the clear liquid is used, the sediment being thrown away, the official lime-and-sulphur formula will not injure the long wool. In our own experiments we have found some samples of wool injured by dipping, while on other samples no appreciable effect was noticeable.

It must not be forgotten that other conditions, such as variations in the feed, pasturing on alkaline land, ill health from any cause, etc., may cause brittleness of the wool, which might be mistaken for the effects of lime and sulphur.

If a lime-and-sulphur dip is used, care must be taken to give the solution ample time to settle, then only the clear liquid should be used, while the sediment should be discarded. In some of our tests on samples of wool we have found that the dip with sediment has produced very serious effects even when no appreciable effects were noticed on samples dipped in the corresponding clear liquid.

Experience has amply demonstrated that a properly made and properly used lime-and-sulphur dip is one of the cheapest and most efficient scab eradicators known, but its use should be confined to flocks in which scab is known to exist, and to shorn sheep, with the exception of very severe cases of scab in unshorn sheep. It should only be used when it can be properly boiled and settled. The use of lime-and-sulphur dips in flocks not known to have scab, especially if the sheep are full fleeced, can not be recommended; in such cases tobacco, or sulphur and tobacco, is safer and equally good.

If a lime-and-sulphur dip is chosen, it is better for ordinary cases to use the solutions containing a small amount of lime and three times as much sulphur as lime, as the Fort Collins formula (33 pounds of sulphur and 11 pounds of lime to every 100 gallons of water) or the Bureau of Animal Industry formula (No. 6) (24 pounds of sulphur and 8 pounds of lime to 100 gallons of water), rather than the formula with a greater proportion of lime.

If the stronger solutions, as the Victorian formula (No. 1), or the present South African formula (No. 3), or the Nevada formula (No. 4) are used at all, their use should be confined to unusually severe outbreaks. Under no circumstances should the Californian formula (No. 7) or formula No. 8 be used. They are too strong, and the latter is especially liable to kill the sheep.

Another objection raised to the use of lime and sulphur is the claim that the "shrinkage" in the sheep after the use of these dips is greater than after the use of other dips. In reply to this objection, raised chiefly by patent-dip manufacturers, it can only be repeated that such has not been the experience of this Bureau (see p. 35), nor was it the experience of Professor Gillette in his experiments in Colorado. The burden of proof for the opposite statement, with exact statistics, rests upon those who raise this objection.

Still another objection advanced against lime and sulphur is that its continued use year after year will gradually decrease the annual

clip. Whether this objection be valid or not, it is scarcely necessary to discuss it in detail in this place; for, in the first place, the average sheep raiser of this country does not keep the same sheep "year after year," but sends most of his sheep (breeding ewes and the rams excepted) to market. Hence there will usually be little opportunity to injure the wool of a given animal "year after year." In the next place, if lime and sulphur are properly used one year, so that the flock is freed from scab and if reinfection be guarded against, it will not be necessary to resort again to lime and sulphur.

These objections have been reviewed somewhat in detail in order to place the facts, so far as obtainable, before the farmer. It is not particularly advised by the Bureau that lime and sulphur be used in this country in preference to sulphur and tobacco, or tobacco alone, or any other effective dip. In fact, it is hoped that within ten years there will be no further use for the lime-and-sulphur dips. At the same time, where it is a choice, on the one hand, between lime and sulphur, with a temporary slight deterioration in the value of wool, but an absence of scab, and, on the other hand, the use of a secret and ineffective patent dip, with the continual presence of scab, and hence permanent deterioration in wool, there can be no doubt that the decision should be in favor of lime and sulphur (properly prepared and properly used).

All things considered, where it is a choice between sacrificing the weight of sheep, and to some extent the color of the wool, by using tobacco and sulphur, and sacrificing the staple of the wool by using lime and sulphur, the farmer should not hesitate an instant in selecting tobacco in preference to lime. The loss in weight by using tobacco and sulphur is not much greater than the loss in using lime and sulphur, while the loss in staple is of more importance than a slight discoloration.

Preparation of the mixture.—Almost as many different methods of preparing the liquid exist as there are different formulæ, some of the methods laying great stress upon sifting both the lime and the sulphur, others laying great stress upon allowing the liquid to settle, others leaving out of consideration both of these points. The method which has been found in the Bureau to be the easiest and most satisfactory is as follows:

A. Take 8 to 11 pounds of unslaked lime, place it in a mortar box or a kettle or pail of some kind, and add enough water to slake the lime and form a "lime paste" or "lime putty."¹

B. Sift into this lime paste three times as many pounds of flowers of sulphur as used of lime, and stir the mixture well.

¹ Many persons prefer to slake the lime to a powder, which is to be sifted and mixed with sifted sulphur. One pint of water will slake three pounds of lime if the slaking is performed slowly and carefully. As a rule, however, it is necessary to use more water. This method takes more time and requires more work than the one given above, and does not give any better results. If the boiled solution is allowed to settle the ooze will be equally as safe.

Be sure to weigh both the lime and the sulphur. Do not trust to measuring them in a bucket or to guessing at the weight.

C. Place the sulphur-lime paste in a kettle or boiler with about 25 to 30 gallons of boiling water, and boil the mixture for two hours at least, stirring the liquid and sediment. The boiling should be continued until the sulphur disappears, or almost disappears, from the surface; the solution is then of a chocolate or liver color. The longer the solution boils the more the sulphur is dissolved, and the less caustic the ooze becomes. Most writers advise boiling from thirty to forty minutes, but we obtain a much better ooze by boiling from two to three hours, adding water when necessary.

D. Pour the mixture and sediment into a tub or barrel placed near the dipping vat and provided with a bunghole about four inches from the bottom and allow ample time (two to three hours, or more if necessary) to settle.

The use of some sort of settling tank provided with a bunghole is an absolute necessity, unless the boiler is so arranged that it may be used both for boiling and settling. An ordinary kerosene oil barrel will answer very well as a small settling tank. To insert a spigot about three to four inches from the bottom is an easy matter. Draining off the liquid through a spigot has the great advantage over dipping it out in that less commotion occurs in the liquid, which therefore remains freer from sediment.

E. When fully settled, draw off the clear liquid into the dipping vat and add enough warm water to make 100 gallons. The sediment in the barrel may then be mixed with water and used as a disinfectant, *but under no circumstances should it be used for dipping purposes.*

A double precaution against allowing the sediment to enter the vat is to strain the liquid through ordinary bagging as it is drawn from the barrel.

In watching the preparation of lime-and-sulphur dips by other parties the Bureau investigators have found some persons who laid great stress upon stirring the sediment well with the liquid before using the ooze. This custom is undoubtedly responsible for a great deal of the prejudice which exists at present against lime-and sulphur dips; and considering the preparation of these dips in this way there is no wonder at the immense prejudice against them in certain quarters.

To summarize the position of the Department on the lime-and-sulphur dips: When properly made and properly used, these dips are second to none and equaled by few as scab eradicators. There is always some injury to the wool resulting from the use of these dips, but when properly made and properly used upon shorn sheep it is believed that this injury is so slight that it need not be considered; on long wool the injury is greater and seems to vary with different wools, being greater on a fine than on a coarse wool. This injury consists chiefly in a change in the microscopic structure of the fiber, caused by the caustic action of the ooze. When improperly made and improperly used the lime-and-sulphur dips are both injurious and dangerous, and

in these cases the cheapness of the ingredients does not justify their use. In case scab exists in a flock and the farmer wishes to eradicate it, he can not choose a dip which will bring about a more thorough cure than will lime and sulphur (properly made and properly used), although it will be perfectly possible for the farmer to find several other dips which will, when properly used, be nearly or equally as effectual as any lime-and-sulphur dip. There is no dip to which objections can not be raised.

POTASSIUM SULPHIDE DIP.

It has been proposed by several parties to use a potassium sulphide dip, and such a dip has been tried to some extent. As yet, however, judgment upon it must be reserved. Gillette tried a dip composed of $4\frac{1}{2}$ pounds of potash lye, 16 pounds of flowers of sulphur, and 100 gallons of water, and promises farther reports on its effectiveness. Sheep dipped in this liquid gained but 6 pounds, namely, the same as the sheep treated with carbolic dip.

TOBACCO DIPS.

The active principle of tobacco, upon which the tobacco dips depend for their action, is a poisonous substance known as nicotine. This poison when applied to animals externally in too strong solutions may cause nausea, fainting, and even death. The dog and the rabbit are particularly susceptible to its effects. Diluted to about thirty-three one-thousandths to sixty one-thousandths of 1 per cent it makes a slow but sure-acting and excellent sheep dip.

Unfortunately the percentage of nicotine varies greatly, not only in different kinds of tobacco, but also in different parts of the plant, in different years, and even in different parts of the same package. There is more nicotine in the leaves, for instance, than in the stems. In fermented tobacco there seems to be a certain relation between the amount of nicotine and the amount of juice present, so that in general dry, thin leaves do not contain so much nicotine as thick, "fat" leaves. The variation in percentage of nicotine in different kinds of tobacco may be seen from the following table of determinations taken from Kissling, 1893:

Statement giving the name of tobacco and amount of nicotine in percentage of dry substance.

	<i>Percent.</i>		<i>Percent.</i>
Virginia	1.80	Brazil	1.14
Virginia	4.30	Turkish	2.51
Kentucky	1.50	Elsace	1.91
Sumatra	4.10	Elsace	0.92
Seedleaf	3.70	Maryland	1.26
Seedleaf	3.00	Maryland scrubs	1.17
Havana	3.00	Carman	1.18
Havana	1.90	Ohio Bay	1.66
Brazil	2.78	Ambaluma	1.17
Brazil Felix	2.73	Domingo	0.82
Brazil Felix	1.25	Ohio	0.68
Java	2.61		

In four carloads of stems, aggregating 127,273 pounds, one American firm extracted 1,405.43 pounds of nicotine, or 1.104 per cent.

While the above figures represent the percentages extracted in the chemical and manufacturing laboratories, they do not necessarily represent the amount which the farmer would be able to extract with the methods and apparatus at his disposal. On account of the variation in the amount of nicotine in the different samples of tobacco, it is practically impossible for the farmer to make up an exact desired strength of tobacco dip if he prepares his own mixture from the leaves. He can, however, prepare a mixture which will come within the limits necessary to kill the scab parasites. If a solution of an exact given strength is desired, it will be necessary to buy prepared nicotine, or prepared tobacco dips of a guaranteed strength and reduce them to the strength determined upon.

To prepare the tobacco dip from the leaves, it is best to use at least 21 pounds of leaves to every 100 gallons of water. Assuming that a tobacco leaf is used from which the farmer might extract 2 per cent of nicotine, the 100 gallons of ooze would contain slightly more than five hundredths of 1 per cent; to obtain 100 gallons of ooze of thirty-three one-thousandths of 1 per cent strength, it would be necessary to use 21 pounds of tobacco yielding nearly 1.3 per cent nicotine.

Directions for preparing the dip.—For every 100 gallons of dip desired, take 21 pounds of good prepared tobacco leaves; soak the leaves in cold or lukewarm water for twenty-four hours in a covered pot or kettle; then bring the water to near the boiling point for a moment and, if in the morning, allow the infusion to draw for an hour; if in the evening, allow it to draw over night; the liquid is next strained (pressure being used to extract as much nicotine as possible from the wet leaves) and diluted to 100 gallons per 21 pounds of tobacco. This dip should be used as fresh as possible as it contains a large amount of organic material which will soon decompose.

The proportions here given, 21 pounds of prepared tobacco leaves to 100 gallons of water, have given very satisfactory results, especially in Cape Town colony, where the reports of the scab inspectors accord this homemade tobacco dip third place among the dips officially recognized. In regard to one of the proprietary tobacco dips the Cape Town agricultural department reports as follows: "Highly spoken of by several inspectors. Very efficacious, and improves the quality of the wool, making it soft and pliable. The one thing which militates against its general use is its expense, hindering the poorer farmers from using it. It is allowed to be one, if not the best, of the patent dips in use, and also the safest." By all means the use of a tobacco dip, or of the tobacco-and-sulphur dip, in preference to the lime-and-sulphur dips is advised in case the sheep to be dipped show no unmistakable signs of scab.

The advantages of the tobacco dip are that it is comparatively cheap,

since the farmer can grow his own tobacco; that it is effectual and at the same time not injurious to the wool. The disadvantages of the dip are that it sometimes sickens the sheep; that it also occasionally sickens the persons who use it, especially if they are not smokers; it spoils very rapidly; it causes a greater setback than lime and sulphur, but less of a setback than carbolic dips.

ARSENICAL DIPS.

There are both homemade arsenical dips and secret proprietary arsenical dips. It is well to use special precautions with both because of the danger connected with them. One of the prominent manufacturers of dips, a firm which places on the market both a powder arsenical dip and a liquid nonpoisonous dip, recently summarized the evils of arsenical dips in the following remarkable manner:

The drawbacks to the use of arsenic may be summed up somewhat as follows: (a) Its danger as a deadly poison. (b) Its drying effect on the wool. (c) Its weakening of the fiber of the wool in one particular part near the skin, where it comes in contact with the tender wool roots at the time of dipping. (d) Its not feeding the wool or stimulating the growth, or increasing the weight of the fleece, as good oleaginous dips do. (e) The danger arising from the sheep pasturing, after coming out of the bath, where the wash may possibly have dripped from the fleece, or where showers of rain, after the dipping, have washed the dip out of the fleece upon the pasture. (f) Its occasionally throwing sheep off their feed for a few days after dipping, and so prejudicing the condition of the sheep. (g) Its frequent effect upon the skin of the sheep, causing excoriation, blistering, and hardness, which stiffen and injure the animal, sometimes resulting in death.

Although this manufacturer has gone further in his attack upon arsenic than this Bureau would have been inclined to do, it must be remarked that when a manufacturer of such a dip can not speak more highly of the chief ingredient of his compound than this one has done in the above quotation, his remarks tend to discredit dips based upon that ingredient. It might be added that Bruce, the chief inspector of live stock for New South Wales, pays his respects to arsenical dips with the statement, "Arsenic and arsenic and tobacco (with fresh runs) cured 9,284 and failed with 9,271."

It may be said, on the other hand, that arsenic really has excellent scab-curing qualities; it enters into the composition of a number of the secret dipping powders and forms the chief ingredient in one of the oldest secret dips used. This particular dip has been given second place (with some qualifications) among the officially recognized dips in South Africa. In deference to the opinion of those who prefer an arsenical dip several formulæ are quoted here.

Formulæ for arsenical dips.—Finlay Dun recommends the following: Take 3 pounds each of arsenic, soda ash (impure sodium carbonate) or pearl ash (impure potassium carbonate), soft soap, and sulphur. A pint or two of naphtha may be added if desired. The ingredients are best dissolved in 10 to 20 gallons of boiling water and cold water is

added to make up ¹120 gallons. The head of the sheep must, of course, be kept out of the bath.

A mixture highly indorsed by certain parties consists of the following ingredients:

Commercially pure arsenite of soda	pounds..	14
Ground roll sulphur	do....	34½
Water.....	gallons (U. S.)..	432

The arsenite of soda is thoroughly mixed with the sulphur before being added to the water.

Precautions in use of arsenical mixtures.—Any person using an arsenical dip should bear in mind that he is dealing with a deadly poison. The following precautions should be observed:

(1) Yards into which newly dipped sheep are to be turned should first be cleared of all green food, hay, and even fresh litter; if perfectly empty they are still safer. (2) When the dipping is finished, the yard should be cleaned, washed, and swept, and any unused ooze should at once be poured down a drain which will not contaminate food or premises used by any animals. (3) Dipped sheep should remain in an open, exposed place, as on dry ground. (4) Overcrowding should be avoided, and every facility given for rapid drying, which is greatly facilitated by selecting fine, clear, dry weather for dipping. (5) On no account should sheep be returned to their grazings until they are dry and all risk of dripping is passed.

Suggestion as to danger.—The formulæ given above are copied from the writings of men who have had wide experience in dipping, but this Bureau assumes no responsibility for the efficacy of the dips given or for their correct proportions. Furthermore, as long as efficacious non-poisonous dips are to be had, we see no necessity for running the risks attendant upon the use of poisonous dips.

CARBOLIC DIPS.

A carbolic-acid dip may be made at home or may be purchased as a proprietary article. This class of dips kills the scab mites very quickly, but unfortunately the wash soon leaves the sheep, which is consequently not protected from reinfection in the pastures. If, therefore, a carbolic dip is selected, it is well to add flowers of sulphur (1 pound to every 6 gallons) as a protection against reinfection.

The advantages of carbolic dips are that they act more rapidly than the tobacco or sulphur dips, and that the prepared carbolic dips are very easily mixed in the bath. They also seem, according to Gillette, to have a greater effect on the eggs of the parasites than either the sulphur or the tobacco dips. The great disadvantages of this class of dips are, first in some of the proprietary dips, that the farmer is uncertain regarding the strength of material he is using; second, the sheep

¹ The original formula reads 100 (imperial) gallons, which equal 120 United States gallons.

receive a greater setback than they do with either lime and sulphur or tobacco.

Gillette reports most excellent results from the use of a certain prepared carbolic dip. The Bureau purchased the same dip upon the open market and tested its effects upon the sheep in the proportion recommended by the manufacturer on the label of the package and also in one-half and one-third that strength. In the first and second tests the dip was severe both on the sheep and on the operators. In one case it caused a considerable, though temporary, eruption on the hands and arms of an operator. In all three cases the dipped sheep were almost overcome in the dipping tank, and upon recovering themselves ran around the field in an excited manner, bleating loudly and shaking their heads and tails. The eyes were more congested than we have ever seen them to be after a lime-and-sulphur or a tobacco dip.

An objection to some of the proprietary carbolic dips is that the manufacturers themselves apparently are little acquainted with their own mixtures. Their claims are extravagant and their directions often contradictory. It may be admitted that the carbolic dips are promising and that they may have a brilliant future, but they have not had a very brilliant past, and this Bureau is inclined to be extremely conservative in regard to them and to advise their manufacturers to prepare them in a guaranteed strength with more explicit directions for use than are to be found in the present circulars. The dip just referred to was certainly more severe in its effects on the sheep than can be justified by its quick action in killing the scab parasites, considering that other equally effective but milder solutions are to be had.

We also found in our tests (which are not yet fully completed) that the sheep have gained less in weight when dipped in certain two of these washes than when dipped in lime and sulphur, or in sulphur and tobacco, or in tobacco.

If a carbolic dip is used care must be taken that the ingredients form a thorough emulsion; if a scum arises to the top, a softer water should be used.

In justice to this class of dips it is only fair to state that while the views here expressed are entirely in accord with the opinions of some authorities, they do not agree with the views held by others; but they are based upon the material purchased in open market, and probably represent the experience of many who have used these dips. The investigations of the Bureau certainly show that more tests are necessary before this class of dips can be indorsed. It is hoped that these tests may be made in the near future.

One of the prominent proprietary carbolic dips was formerly recognized as one of the three official dips in New South Wales, but it has now been stricken from the list. In Cape Town carbolic dips are not much used, and in the official reports little is said concerning them.

SETBACK TO THE SHEEP FROM DIPPING.

Dipping often results in a slight setback. If sheep are weighed immediately before dipping, and again at the same hour the following day, it will be noticed that the weight has changed. There may be a gain, but usually there is a loss varying from $\frac{1}{2}$ to $3\frac{1}{2}$ pounds. The second day there may also be either a gain or loss. As the weight of sheep varies from day to day, from 1 to 5 pounds in loss or gain, due chiefly to the increase or decrease of the amount of fodder and water in the stomach, the effects of dipping can not be estimated in twenty-four or forty-eight hours. In order to meet statements made concerning loss or gain in weight, this Bureau had sheep dipped at stated intervals, and the weights taken from week to week; all the sheep were kept under exactly the same conditions; the dips used were lime and sulphur, tobacco and sulphur, and two proprietary carbolic dips.

At the end of about two months, after three dippings, all of the sheep showed a gain, with the exception of one of the sheep from the carbolic dip, which lost slightly. The lowest gain among the sheep treated with tobacco dip was $3\frac{1}{2}$ pounds, the highest $11\frac{1}{2}$ pounds. The lowest gain among the sheep treated with lime and sulphur was 7 pounds, the highest $8\frac{1}{2}$ pounds. The lowest gain among the sheep treated with the carbolic dip was $1\frac{1}{2}$ pounds, the highest $3\frac{1}{2}$ pounds, while one animal lost $\frac{1}{2}$ pound. The sheep were given a fourth dipping, and at the end of another month showed the following gains and losses over their original weight at first dipping: Sheep treated with tobacco, 9 to 15 pounds gain; sheep treated with lime and sulphur, $11\frac{1}{2}$ to 14 pounds gain; sheep treated with carbolic dip, 1 to $6\frac{1}{2}$ pounds gain, in one case $13\frac{1}{2}$ pounds lost.

The experiment was then repeated, the lime and sulphur being used on sheep previously dipped in carbolic or tobacco dips, and vice versa. After ten days the sheep treated with lime and sulphur had gained from 2 to 3 pounds; the sheep treated with tobacco had remained stationary or had lost from 1 to $1\frac{1}{2}$ pounds; the sheep treated with carbolic dip had gained as high as 1 pound, or remained stationary, or had lost as much as $2\frac{1}{2}$ pounds. At this point circumstances intervened which closed the experiments for the season.

Gillette has also made determinations of the loss of weight of sheep from dipping. Part of his results agree with ours and part differ. The chief point of difference in opinion is that Gillette considers that the best conclusion can be based upon weights taken a few days after dipping, while we consider the weight at a later period as the better criterion. Gillette gives weights from November 17 to December 22, and, taking the cases where the sheep have been dipped twice, we see from his tables that the carbolic sheep gained on an average 6 pounds, the sheep treated with tobacco gained 8 pounds, the sheep treated with arsenical dip gained 8 pounds, the sheep treated with lime and

sulphur¹ gained 9 pounds, while the sheep which were not dipped, in order to give a basis for comparison, gained 6 pounds.

Holding in mind that sheep may apparently gain or lose about 3 pounds per day when not dipped, it is seen from the experiments by Gillette, in Colorado, and by this Bureau, in the District of Columbia, that the oft-repeated claim that lime-and-sulphur dips give a greater setback than other dips is erroneous. In both the Western and the Eastern experiments the sheep treated with lime and sulphur averaged the greatest gain, the sheep treated with tobacco the second highest gain, while the carbolic sheep showed the lowest gain.

DIPPING PLANTS.

There are numerous kinds of dipping plants in use, the size and style varying according to the conditions which are to be met and the individual taste of the owner.

The farmer who has but a small flock can use a small portable vat for dipping, turning a part of his barn or some shed into a catching pen; by holding the sheep a moment at the top of the incline, as the animals emerge from the vat, and allowing them to drain, he can do away with the necessity of a draining yard.



FIG. 5.—A simple cauldron which may be used for boiling dip.

When large flocks are to be dipped at stated periods it will be economy to build a more permanent plant. Such a plant should consist of (1) collecting and forcing yards, provided with a (2) drive and (3) chute, or slide, into the (4) dipping vat, from which an (5) incline with cross cleats leads to the (6) draining yards.

Heating tanks or boilers are also necessary. For a small vat any

portable cauldron (figs. 5 and 6) with a capacity of 30 to 100 gallons will answer, and the proper temperature may be maintained by pouring fresh hot ooze into the vat as the supply is exhausted by the dipping. In the large permanent plants the temperature can best be regulated by means of a steam pipe or hot water coil close to the floor of the tub.

Thermometers are an absolute necessity. The floating dairy thermometer (fig. 7) will be found to be most convenient, and several extra thermometers should be kept on hand to replace broken instruments. The thermometer is dropped into the vat and allowed to float for a short time, then quickly removed and the temperature determined. It is well to make paint marks at the side of the 100° and 110° points.

¹Unfortunately for the comparison this lot did not receive the same fodder as the others.

Building material.—The yards and vat may be built of wood, concrete, cemented stone, or brick, according to the individual taste of the owner and the facilities at hand.

Dimensions.—The dimensions of the various parts given in the following descriptions may be varied according to the breed and the number of sheep to be dipped. Dipping liquid will be saved by making the tub much narrower on the bottom than at the top. On top, simple oblong dipping tanks vary from 1 foot 9 inches to 3 feet in breadth, 2 feet or 2 feet 6 inches forming a convenient medium. Floors vary from 6 inches to 3 feet in width, 9 inches forming a good working medium. Depth varies from 3 feet to 5 feet 6 inches, 4 feet to 5 feet forming a



FIG. 6.—A caldron with stove.

convenient medium. If calves are to be dipped in the same vat it will be best to make the tub 5 feet or 5 feet 6 inches deep.

In sinking the tub in the ground it is always well to have the top of the tub 9 inches above the ground line. It is also well to sink one end (where the sheep are thrown in) slightly lower than the other end, as this will make it easier to empty and clean the vat.

Crutches, or forks.—In using large vats crutches, or dipping forks, are necessary, and even with small vats they are useful. Crutches should be 5 or 6 feet long. The handle should be strong (rake handles are a little too light). One end is provided with an iron ferrule, into which the bent iron is inserted. The iron should be one-half inch round

or three-quarters inch half round. The form of the crutches is shown in figs. 8 and 9.

Gauges.—The capacity of tubs should be plainly marked on the side every 3 or 6 inches, in order to correctly measure the amount of liquid.

SMALL PORTABLE VATS FOR SMALL FLOCKS.

If no regular dipping vat is at hand a good-sized tub may be used, as shown in fig. 10. Dipping in this manner is slow and tedious, but may be resorted to in case of necessity, as, for instance, when a few sheep are bought from another flock which is not known to be absolutely free from scab. If care is taken to dip thoroughly the dipping may be done as effectually in such a tub as it could be done in a large vat. Recourse to ordinary tubs is not advised, however, when it is possible to use regular dipping vats. Lambs may, in case of necessity, be dipped in troughs, as shown in fig. 11.

A small portable vat, suitable for use in dipping small flocks, is shown in fig. 12. When not in use this vat may be conveniently stored away. An advantage connected with this vat is that it may be drawn from place to place as desired. The dimensions here given may be varied, according to individual taste, by making the vat longer, broader, or deeper. A convenient size will be 9 feet long by $2\frac{1}{2}$ feet broad at the top, 9 inches broad at the bottom, and $3\frac{1}{2}$ to 5 feet deep; the floor measures 9 inches broad by 4 feet long; from 1 foot above one end of the floor a slant with cross cleats rises to the top and end of the vat. The sheep are dropped in by hand, one at a time, at the deep end, and after being held in the dip for two minutes are allowed to leave the vat at the slanting end. They are held a moment on the slant to allow them to drain off, thus economizing in dip. A gate may be placed at the deeper part of the slant if desired, in order to save labor. This gate should swing toward the exit of the vat. Such a tank may be made of $\frac{1}{2}$ -inch pine boards, with tongue and groove, and should be well pitched or painted.

This plan of vat may be easily modified, if desired, so as to have a small dripping pen attached, as shown in figs. 13 and 14. In this modified plan an inclined platform is added to the vat shown in fig. 12 and a removable skeleton box is made to fit over it. While one sheep is being dipped another sheep is allowed to ascend the incline into the small dripping pen. When the sheep is sufficiently drained the gate is opened, it leaves the pen, the gate is closed, the sheep in the vat enters the pen, and another sheep is placed in the vat.

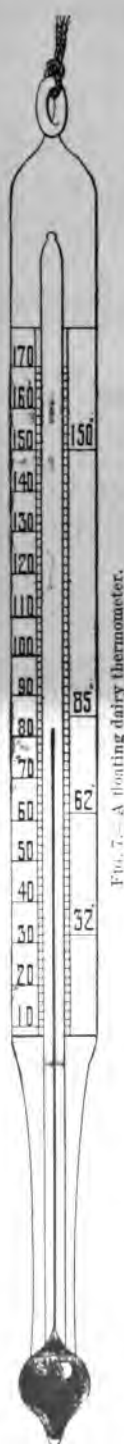


FIG. 7.—A floating dairy thermometer.

A small portable vat used in some places is shown in figs. 15 and 16. Dipping in a vat of this kind may be thorough, but is tedious.

Another style of small vat suitable for holding three sheep at a time is shown in fig. 17. It is estimated that 1,500 sheep may be dipped in this tub in a single day. The dimensions of the plant are given in the diagram, and need no further explanation.



FIG. 8.—A crutch, or dipping fork. (Copied from the Agricultural Journal, 1894, p. 261.)



FIG. 9.—Another style of crutch, or dipping fork.

MORE PERMANENT PLANTS FOR LARGER FLOCKS.

RECEIVING AND FORCING YARDS.

Where large numbers of sheep are to be dipped, it is necessary to build receiving pens close to the dipping vat. The number and size of the pens vary with the number of sheep to be handled. The yards



FIG. 10.—Dipping sheep in a tub. (Copied from Stewart's The Shepherd's Manual, 1882, p. 47.)

may be either square or oblong, as shown in figs. 17 and 18, or they may be circular, as shown in fig. 19. The square or oblong yards are the more simple in construction and need no detailed description, as all details may be seen by consulting the diagrams. The circular yard, however, needs a word of explanation.



FIG. 11.—Trough for dipping lambs. (Copied from Stewart's *The Shepherd's Manual*, 1882, p. 48.)

In using the circular yards (fig. 19) two natural habits of the sheep are turned to practical account, so as to lessen the work of driving, namely, the habit sheep have of "ringing" when disturbed in a yard, and the tendency they show to escape at the point where they enter an inclosure.

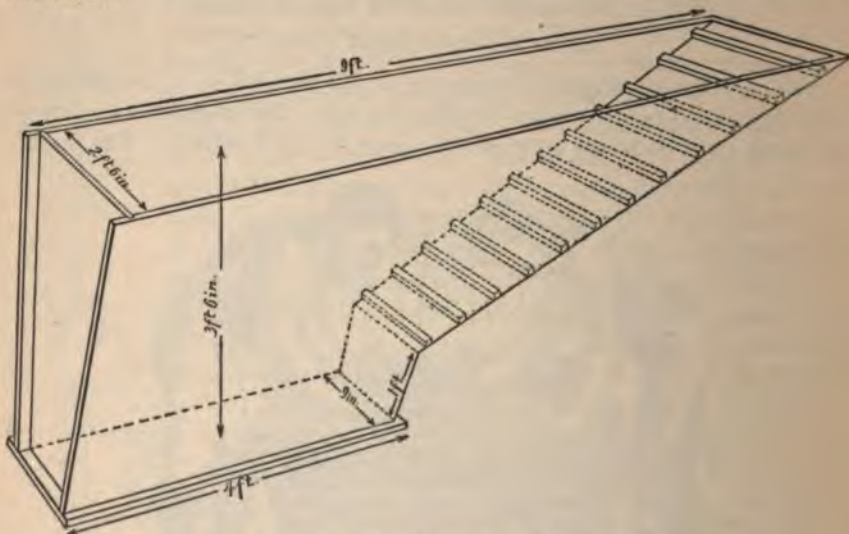


FIG. 12.—A small portable dipping vat for small flocks.

The flock is yarded at *AB* and find its way into yards 1 and 2 through the openings *CD* and *CE*. When these yards are full the gates *CD* and *AB* are closed to form yard 6. The sheep then circle through yards 3, 4, 5, and 6, coming to the point at which they entered

and expecting to escape. When yards 3, 4, 5, and 6 are filled the other gates are closed, so that the sheep can not return to yards 1 and 2. If

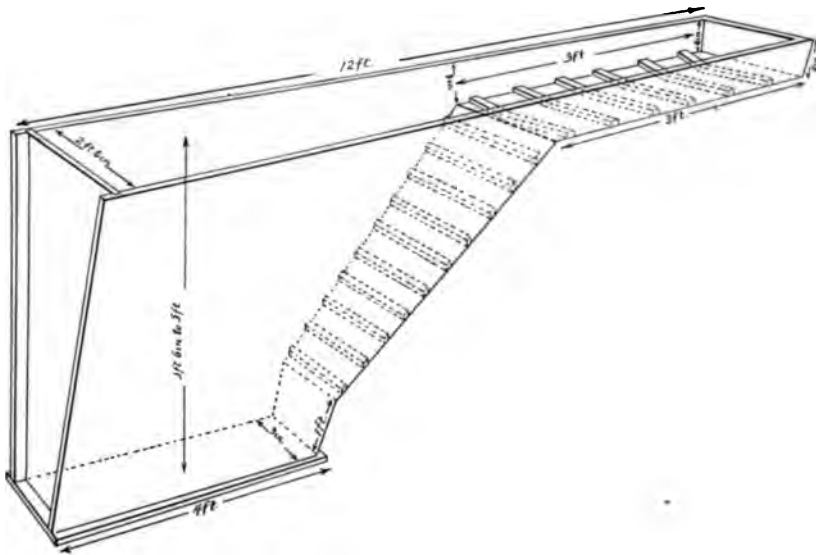


FIG. 13.—A small portable dripping vat with attached dripping platform.

the animals hesitate to enter yards 3, 4, 5, and 6, another natural tendency of the sheep may here be turned to account. A man jumps over the fence and runs through the flock in the opposite direction (6, 5, 4, 3)

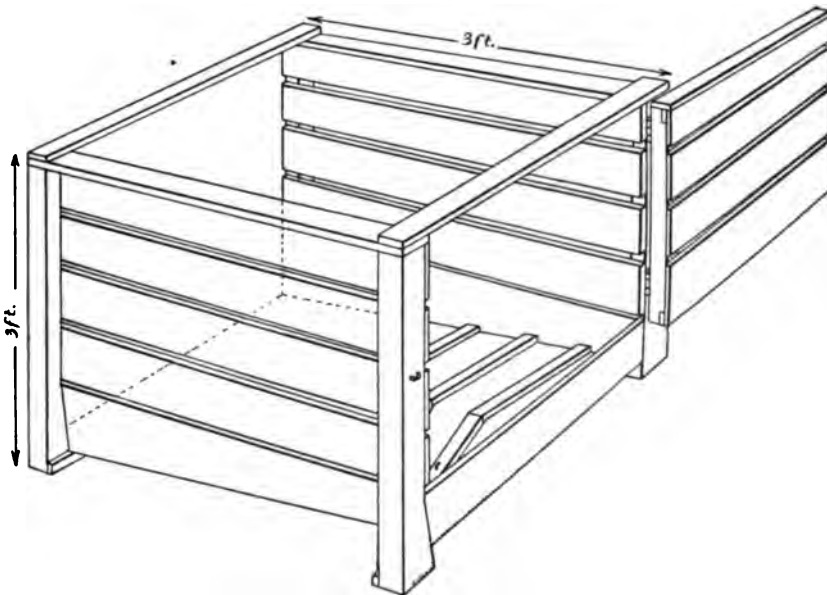


FIG. 14.—Detachable skeleton box, with gate, to fit over the dripping platform shown in fig. 13.

to that in which the animals are wanted to move. This will generally result in starting the sheep in the desired direction.

From the exit of yard 6 (*BC*) there should be built a narrow run extending to the dipping vat. This run should be about 20 feet long by 2½ feet wide, and should be provided with sides high enough, espe-



FIG. 15.—A small patented portable vat arranged as a cart. (Copied from Armatage, 1895, *The Sheep Doctor*, p. 494.)

cially near the vat, to prevent the sheep from jumping over and thus escaping. These sides should be continued a short distance along both sides of the vat. The last 5 feet of this run should slant downward toward the vat at an incline of 25 to 30 degrees, and should be

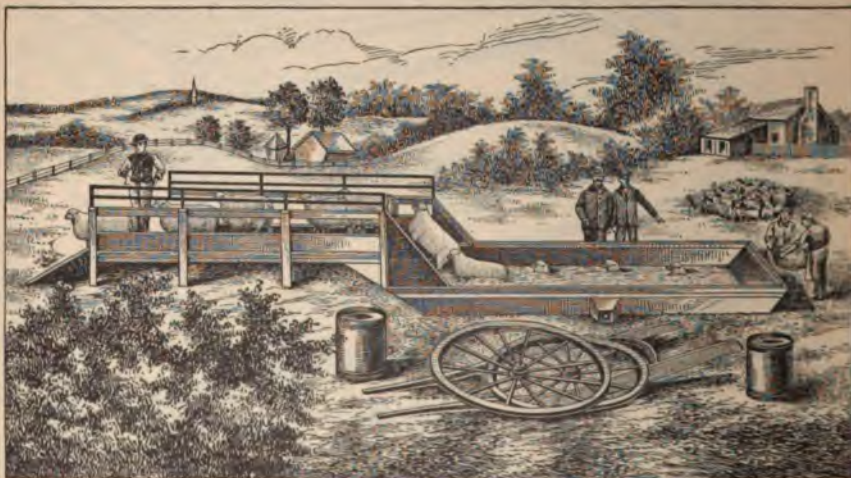


FIG. 16.—Portable vat unfolded and in use. (Copied from Armatage, 1895, *The Sheep Doctor*, p. 494.)

smooth. By pouring upon it some of the dip it may be made slippery so that the sheep will slide into the vat. If there is no natural incline toward the vat, an incline may easily be made by raising the floor of

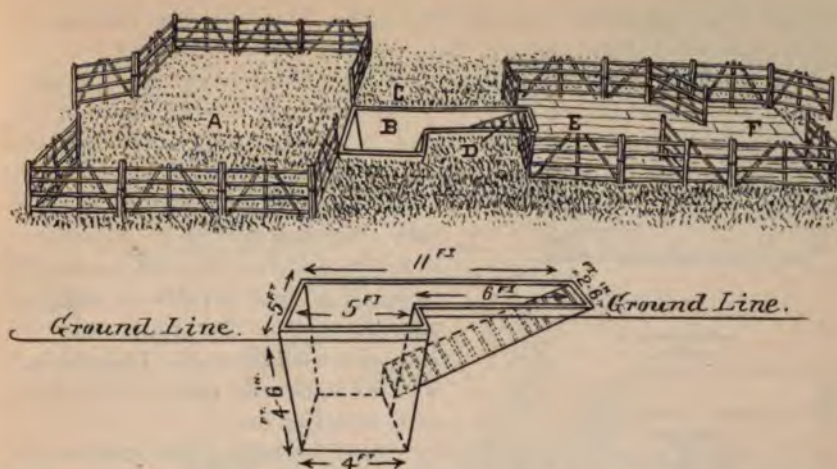


FIG. 17.—A small dipping plant: A, collecting yard; B, dipping vat; C, place for man with fork; D, incline, with cross cleats, to draining pens E and F. Lower diagram gives dimensions of the vat. (Copied from Sutherland's Sheep Farming, 1892.)

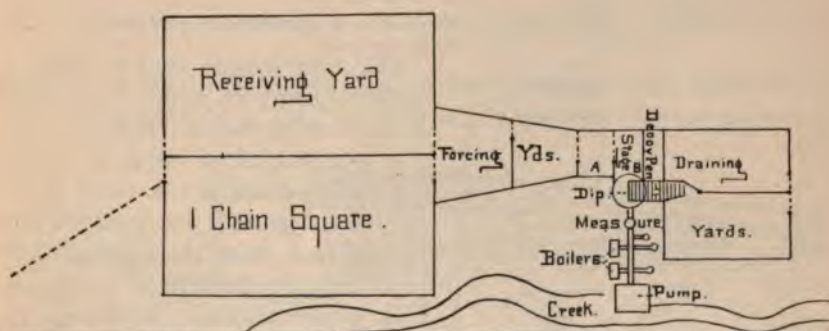


FIG. 18.—Receiving and forcing yards, with attached stage, decoy pen, vat, draining yards, etc. Scale 50 by $1\frac{1}{2}$ inches. (Copied from Bruce's Scab and Its Cure, 1894, p. 17.)

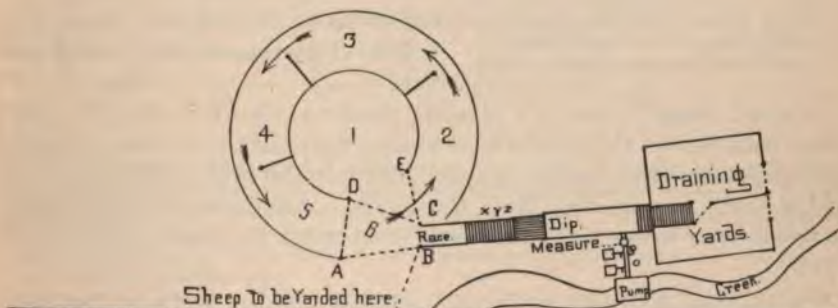


FIG. 19.—Australian circular receiving and forcing yards, with straight race or drive, the incline chute, straight vat, incline, two draining pens, etc. Scale 50 feet to $1\frac{1}{2}$ inches, making the outer circle of the yards about 66 feet in diameter. (Copied from Bruce's Scab and Its Cure, 1894, p. 17.)

the run at a point 5 feet from the vat. The sheep will then pass up the incline *x* to the highest point *y*, then down the incline chute *z*.

Much time will be saved in dipping if the yards and run are arranged in such a way that the sheep in the race can not see the dipping vat. This can be accomplished by either of two simple methods: First, the run, instead of being straight, may be built with a sudden angle at the point *y* (see fig. 19); the vat will then not be visible to the sheep

ascending the incline *x*; or, second, if a straight run is built as shown in fig. 19 a loose curtain of bagging may be hung at the point where the run joins with the vat. This curtain will fall back into place as the sheep drop into the vat.

A modification of the circular pen is seen in fig. 20, taken from Gibson's (1893) *History and Present State of the Sheep Breeding Industry in the Argentine Republic*.

CHUTES, OR SLIDES.

The most simple kind of chute is made by using an incline at the end of the run, as shown in fig. 19.

A second kind of chute in use is the endless-chain or treadmill chute, shown in fig. 21. Its construction can be seen from the diagram and need not be described in detail. This chute may be improved by building it on a slant toward the vat, in which case a bolt or other arrangement must be attached to stop the chute when desired; the weight of the sheep on the movable chute will help to carry the animals toward the vat.

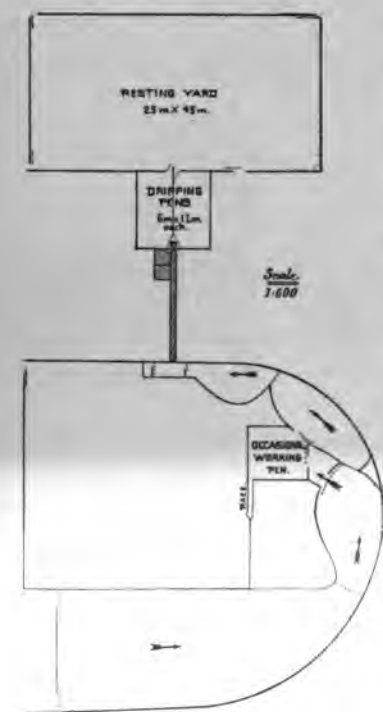


FIG. 20. Argentine semicircular receiving and forcing yards, with a straight vat, draining pens, etc. The dimensions are given in the metric system: 1 m. (meter) equals 39.36 inches. (Copied from Gibson's *History and Present State of the Sheep Breeding Industry in the Argentine Republic*, 1893.)

A third chute in use is a pivoted platform, shown in fig. 22. The sheep walk out on the platform until they overbalance its free end, and then, when a sliding bolt is removed, fall into the tank. The structure of the chute may be seen from the figure. Accidents are more likely to result from using this chute than from using the slant or the chain chute.

For dipping pregnant ewes some persons build a movable platform which can be lowered into the vat and raised at will.

THE DIPPING VAT.

The dipping vat may be made on several different plans: The single oblong straight vat; the double or triple, with turns at the ends; the

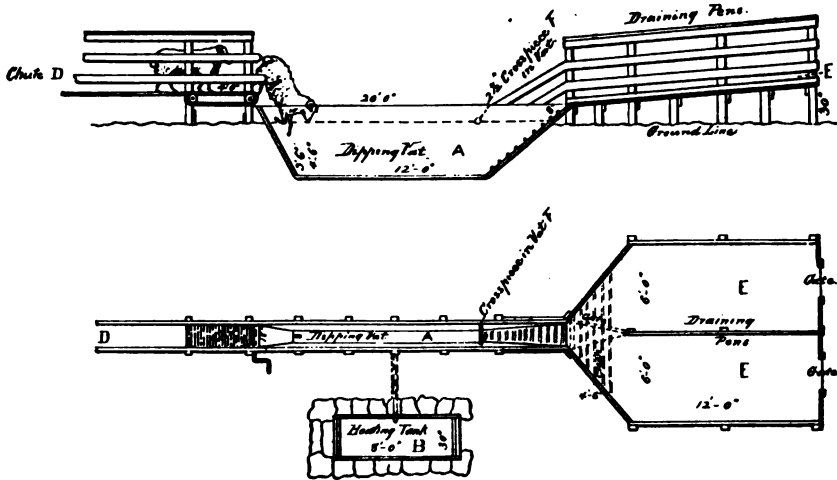


FIG. 21.—Dipping plant provided with an endless-chain or treadmill chute. (Copied from the American Sheep Breeder, 1891.)

square; or the circular. In case of single oblong vats, time will be saved in dipping if a long vat is used, so that the animals may swim

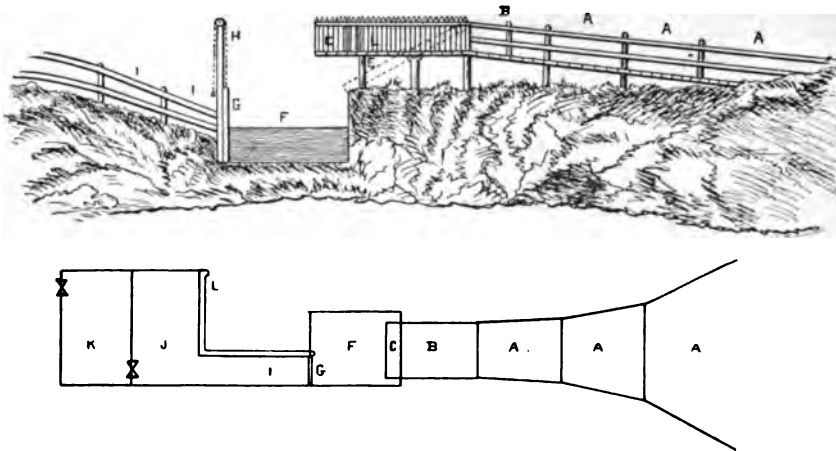


FIG. 22.—Dipping plant illustrating: A, collecting and forcing yards; B, straight drive; C, decoy pen in which several sheep are kept; D, dipping pen with pivoted floor E, secured by a bolt; by withdrawing the bolt the sheep are precipitated into the square tub F; G, sliding gate through which the sheep pass from the tub to the draining pens, J and K; L, channel for drip, conducting the ooze back to the vat. The lower diagram gives a surface view of the upper figure. (Copied from the Veterinarian, 1862, p. 333.)

directly through without stopping, and then leave the tank. Very naturally the longer the vat the more building material and ooze will be required. Vats are in use varying from 10 to 120 feet long.

The single oblong vat.—Single oblong dipping vats are shown in figs. 18, 19, 20, 21, 23. These tanks should be made about $2\frac{1}{2}$ feet broad at

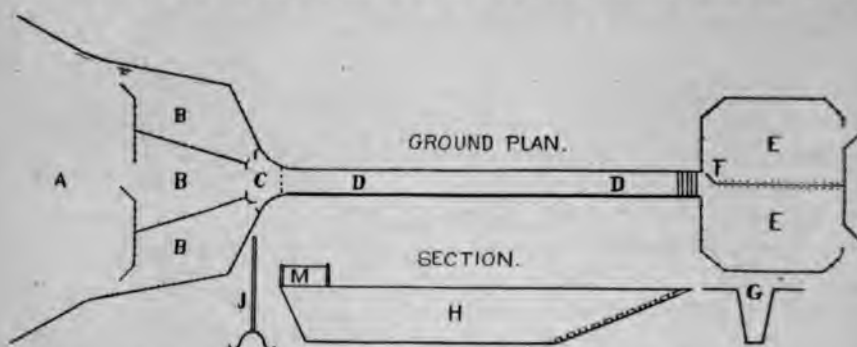


FIG. 21.—A, collecting yard for the sheep which are to be dipped; B, B, B, small pens leading to C, an inner pen with an inclined chute, or in which a man may stand to pass the sheep one at a time into the vat; D, D, the tub, which should measure from 20 to 120 feet long, 21 to 30 inches broad at the top, 6 to 9 inches broad at the bottom; M, board 2 feet high on each side of the entrance of the vat to catch the splash and to prevent the sheep from escaping; E, E, draining, or dripping, pens; F, swinging gate; G, cross section of the tub; J, crutch for keeping the backs of the sheep under the surface, and for catching or holding sheep in the dip. (This drawing is taken from the *Agricultural Journal*, III, 1891, p. 236; it was also published in the *American Sheep Breeder*, Feb. 15, 1892.)

the top, 9 inches broad at the bottom, and 4 to 5 feet deep; the length may be 20 to 120 feet, as desired. One end (the entrance) should be straight, as shown in figs. 24 and 26, or with a steep slant, as shown in figs. 21, 23, and 25, while the last 5 to 14 feet at the other end (exit) should have a gradual slant with cross cleats.

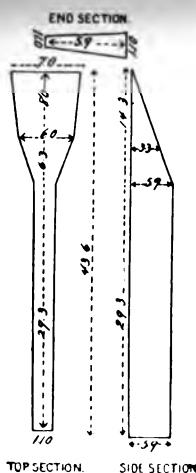


FIG. 24.—A straight vat known as the Australian sheep dipping tank.¹

The square vat.—A square vat is shown in fig. 22. This tub should be 5 feet deep, and large enough to hold 10 or 12 sheep at a time. The square vat does not present any particular advantages over narrow oblong vats, except that it gives the sheep an opportunity to swim around. This kind of a vat is not in very general use among large herders.

The triple vat.—In the triple vat (fig. 28) the sheep come through the run, or drive, and slide into the first vat at A; swimming in the direction of the arrows they round the turns B and C, ascend the incline D, and enter the draining pens. The theory upon which this triple vat is used is that upon rounding the point B the sheep bend toward the left, thus crumpling the scabs on the left side and opening the wool on the right; upon rounding the point C they bend toward the right, crumpling the scabs of that side and opening the

¹This vat is in use at Tulumbah station, New South Wales, and gives much satisfaction. The swimming race is 29 feet 3 inches long, 1 foot 10 inches wide at top, with gradual inward slope to 11 feet at the bottom, and 5 feet 9 inches deep; the landing stage (slant) is 11 feet 3 inches long (surface measurement), with a rise of 5 feet 9 in 14 feet 3 inches. To allow for any weak sheep, which stand in the way and block the others at the end of the swim, the landing stage opens out from 1 foot

wool on the left. This is evidently a more theoretical than practical consideration.

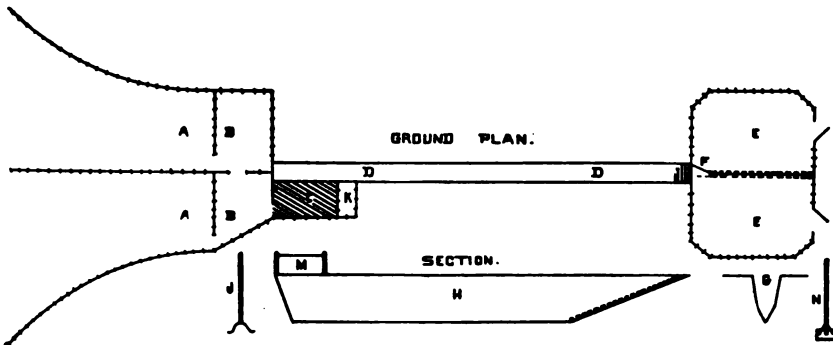


FIG. 25.—A somewhat similar straight swim taken from Sutherland's Sheep Farming: A, collecting pens; B, B, smaller pens; C, small pen at the side of the vat; K, decoy pen in which several sheep are placed to induce the sheep in pen B to enter pen C; D, D, a tub 50 to 60 feet long, 5 feet deep, 21 inches broad until 3 feet from the top, then narrowing to 6 or 8 inches at the bottom, as shown in the cross section; G; M, a board 2 feet high to catch the splash; the last 18 feet of the swim slants gradually, with cross cleats, to the draining pens, as seen in H; E, E, draining pens, worked alternately with the swinging gate, F; each pen measures 24 by 15 feet, and should slant toward the vat; J, crutch 5 or 6 feet long; N, mixer for stirring the liquid.

Each run should be about 15 to 30 feet long and $2\frac{1}{2}$ feet broad; the tank should be $4\frac{1}{2}$ to 5 feet deep and 4 to $7\frac{1}{2}$ feet wide at the bottom.

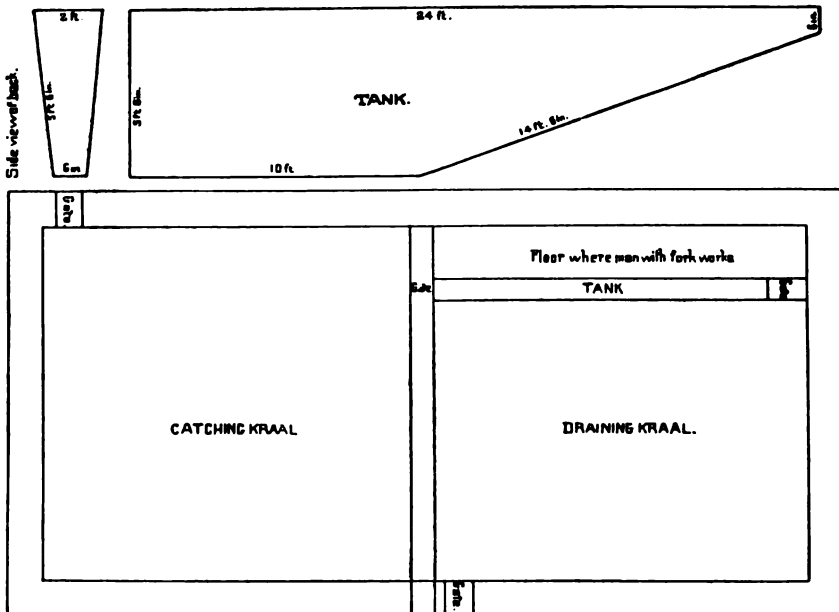


FIG. 26.—A dipping plant figured in the Agricultural Journal, 1894, p. 629, in use in South Africa.

At the point A, where the sheep fall into the swim, it is best to have the floor of the first run $2\frac{1}{2}$ feet wide for a distance of 6 feet, in order

10 inches at top and 11 inches at bottom to a width (top and bottom) of 6 feet at a distance of 6 feet 3 inches (longitudinally) from the end of the swimming race, and gradually widens for the remaining 8 feet of length to a width of 7 feet at the end.

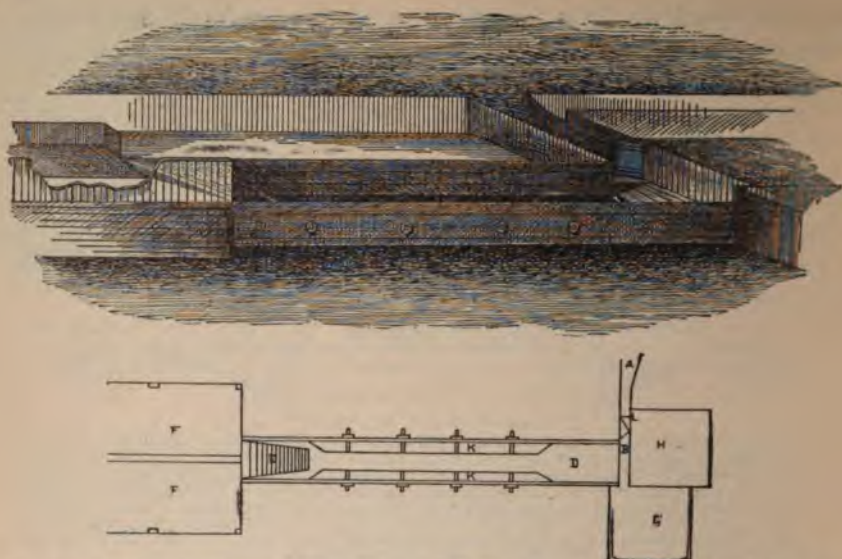


FIG. 27.—A dipping plant in use in Millard County, Utah. *A*, chute from the large corral; *B*, a sloping board over which the sheep in attempting to pass to the decoy pen, *C*, slide into the tank, *D*; *K, K*, two pieces, 2 by 6 inches and 12 feet long, bolted lengthwise of the tank, leaving a 12-inch space in the middle of the dip through which the sheep must put their heads, preventing those in rear from riding those in front, at the same time keeping their backs under the dip. (Copied from Powers' *The American Merino*, 1887, p. 308.)

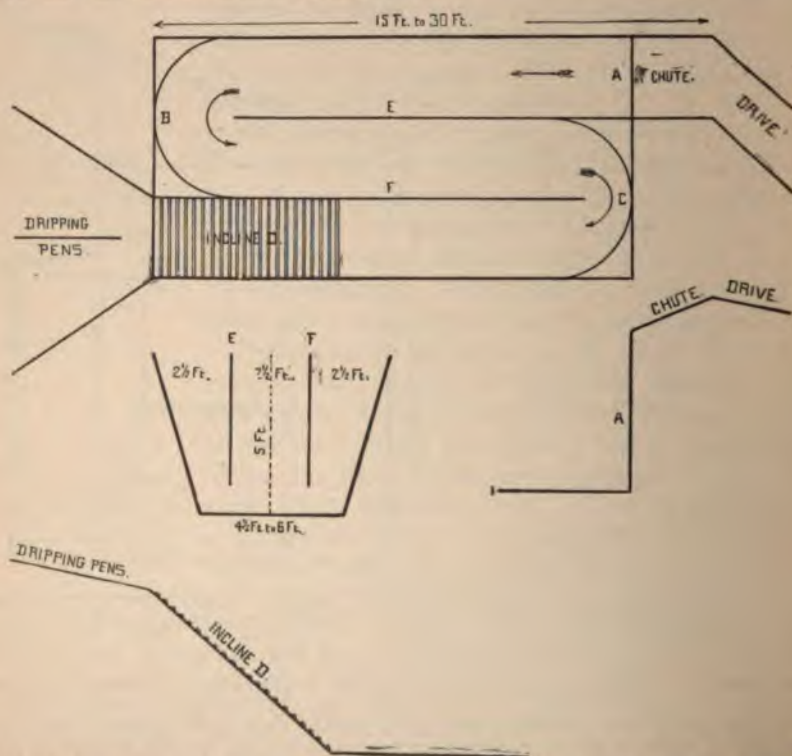


FIG. 28.—A triple vat. The various diagrams give surface view, cross section, vertical section of entrance to the vat, and vertical section of the incline and dripping pens.

to prevent accidents, but beyond that distance the floor may be narrowed in order to save the dipping fluid. If the partitions *E* and *F* are not made solid the ooze will circulate more easily and thus remain at a more even temperature; the boards should be close enough together, however, to prevent the sheep from catching their feet in the cracks. A gate should be arranged at *D*, so that the animals may be delayed in the ooze, if desired. (See also fig. 36 of the triple vat in use at the Chicago Stock Yards.)

The circular vat.—Some parties prefer a circular vat (fig. 29). The advantages set forth in favor of this are, first, a fewer number of men are required to attend to the animals in the tub; second, where it is

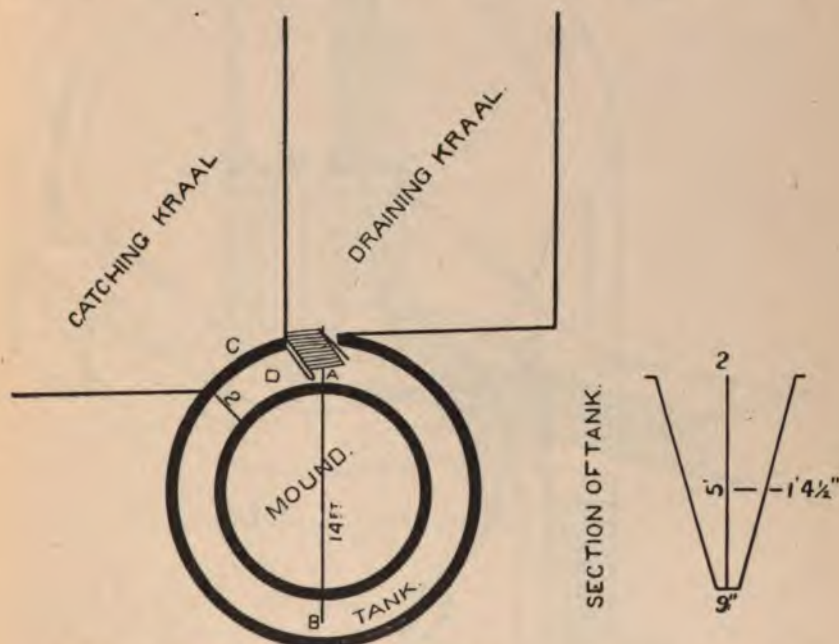


FIG. 29.—A circular dipping tank. (Copied from the Agricultural Journal, 1895, p. 119.)

desired to give any particular sheep an extra long swim, this may be done by quickly closing the gate *D* at the exit, thus compelling the animal to swim around again, without delaying the other sheep; third, by building a circular vat with a circumference of 30 feet the animals may be made to swim around two, three, or four times, thus gaining the advantage of a tank 60, 90, or 120 feet long, yet with a much smaller amount of building and dipping material.

The vat should be $2\frac{1}{2}$ feet broad at the top, 9 inches broad at the bottom, and 5 feet deep. To determine the circumference multiply the diameter by 3.1416.

Despite the advantages of the circular tank in saving material and obtaining the advantages of a long swim, there are two rather serious

objections to it: First, in the vat as shown in fig. 29, it is necessary to throw the animals in by hand, since a chute directed into the circle would lead to accident; second, the circular vat is much more difficult of construction than the straight vat.

These objections may, however, be overcome in several ways, still preserving all the advantages. If a circular vat is preferred and a

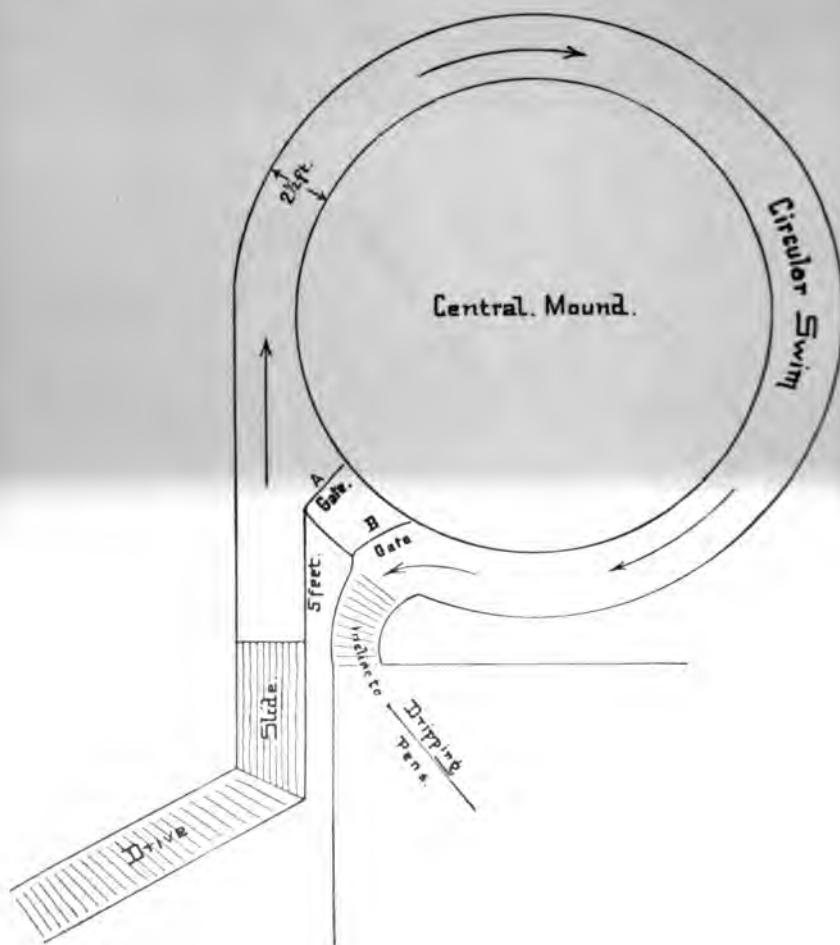


FIG. 30. A circular dipping tank, with drive and slide.

chute is desired, the object may be attained by building a short, straight vat on a tangent to the circle, as shown in fig. 30. In this case, two swinging or sliding gates, *A* and *B*, will be required.

The double vat.—All of the advantages of the circular vat may be combined with the easy construction of the straight vat by building a straight tub with a double channel, as shown in figs. 31 and 32, the

second swim being prolonged in an incline to the draining pens. Such a vat may be constructed as follows:

Build an oblong tub 15 feet long, 5 feet deep, 5 feet wide at the top, and 3 to 5 feet wide at the bottom. Running lengthwise through the center, build an upright, partially open, partition 10 feet long and $4\frac{1}{2}$ feet deep (measured from the top of the tub), leaving an open space of $2\frac{1}{2}$ feet at each end and 6 inches at the bottom; this partition is supported by three uprights running to the floor of the tub, and cross supports may be placed on top of the tub at any point except near the entrance of the

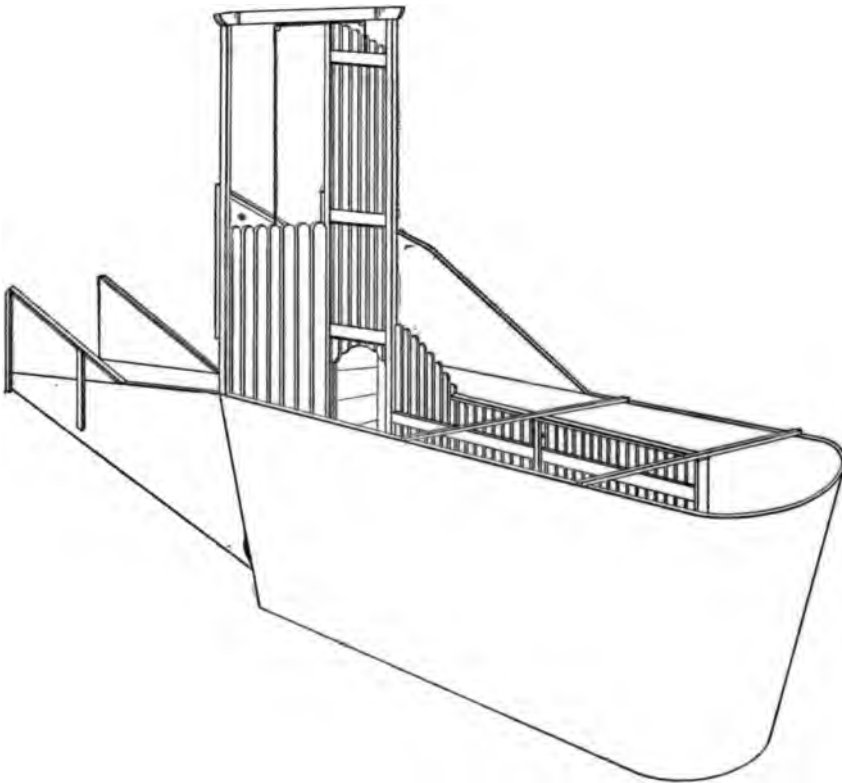


FIG. 31.—View of double oblong swim. (Consult also fig. 32.)

swim. A gate is hung at one end between the slide (entrance) and the incline (exit), and should extend above the tub, in order to prevent the sheep from jumping over the middle partition into the second swim; it should extend down to within about 6 or 12 inches of the floor of the tub. When this gate is closed against the middle partition the sheep will leave the vat by the incline to the draining pens; when it is closed against the incline, the sheep can be forced to swim around the tub two or three times, as desired. Or, in place of a swinging gate, two sliding gates may be arranged to run up and down in grooves, balancing each

other or each balanced separately by weights. One of these gates is placed between the end of the vat and the end of the middle partition, the other is placed at the entrance of the incline to the draining pens.

By constructing the double vat and sending the sheep around three times there would result, first, a saving in the original cost of the tank when compared with a 90-foot straight swim; second, a saving in space; third, less than half as much dip would have to be kept warm at a time; fourth, less than half as much dip would have to be made

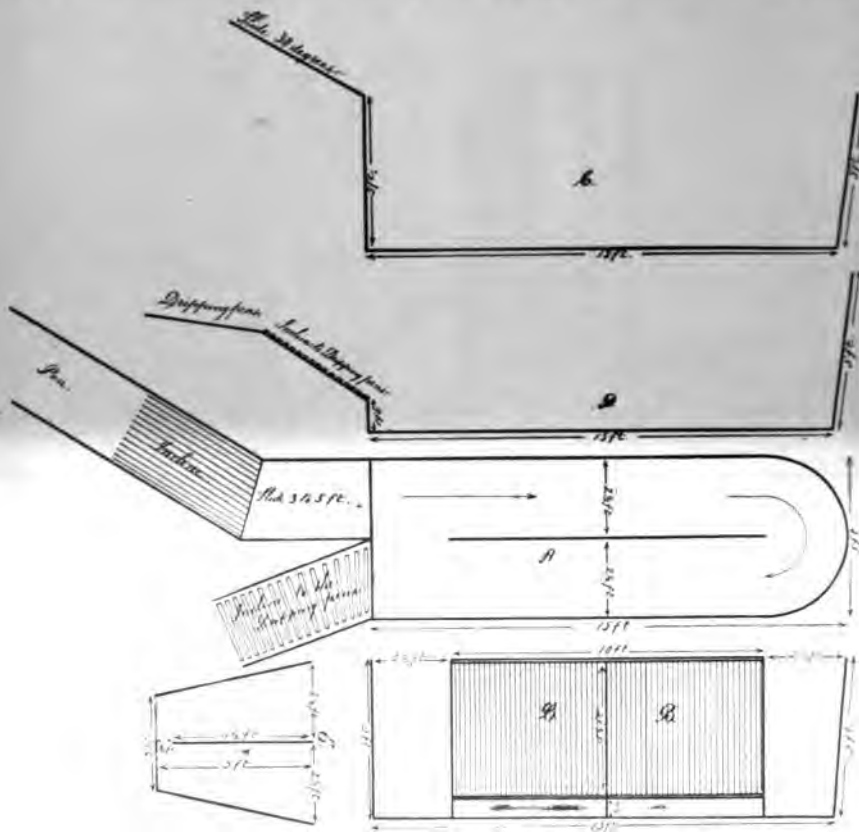


FIG. 32. — A double oblong swim: *A*, ground plan; *B*, side view of the middle partition; *C*, longitudinal section of the first swim; *D*, longitudinal section of the second swim, with incline; *E*, cross section of the entire vat, with partition in the center.

up at a time; fifth, the residue after dipping would be reduced and thus the loss decreased. It would, however, take a longer time to dip a large flock of sheep in such a vat than in a straight vat 90 feet long.

THE INCLINE TO THE DRIPPING PENS.

At the end of the vat an incline, with cross cleats, is built so that the sheep may leave the dip of their own accord and enter the draining pens. A board fence, 2 feet high above the top of the vat, should run

a few feet each side of this incline to prevent the sheep from escaping. These inclines are shown in figs. 21, 23, 25, and 26; the rise for fat heavy wool sheep must not be too steep, otherwise the exertion will be too great. In fig. 24 the incline is 5 feet 9 inches in a surface distance of 14 feet 3 inches. At the Chicago Stock Yards the incline is 9 feet.

Much labor will be saved if a hinged or, still better, a sliding gate

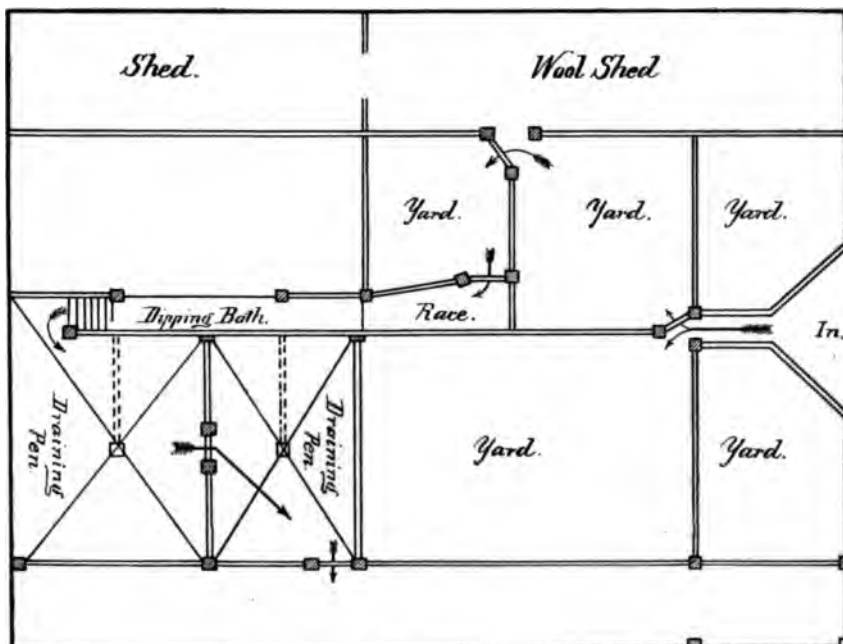


FIG. 33.—Ground plan of yards and vat. (Copied from Armatage, 1895, *The Sheep Doctor*.)

is placed at the deepest portion of the incline. The sheep may thus be held in the dip as long as desired; when the time is up the gate is opened and the sheep enter the draining pens.

THE DRIPPING PENS.

There should be two dripping pens side by side (figs. 17, 18, 21, 23, and 33) with a swinging gate at the entrance; one is filled, the gate is then closed, opening the other pen; when the second pen is filled the first pen is emptied; or the pens may be in direct line with the vat (figs. 17 and 22).

These pens should have a slight incline toward the tub so that the dripping ooze will run back to the tub. A good plan is to build the incline from the sides toward the center fence; under the fence build a partially covered gutter inclining to the tub; the cover of the gutter should be removable to allow cleaning; at the end of the gutter nearest the tub place a grating to catch the wool and droppings, thus preventing these materials from being washed into the dip.

SHELTER FOR THE DIPPING PLANT.

The vat, boilers, and dripping pens should be under cover, and it will be well to extend the cover over the drive and the forcing pens.

ARRANGEMENTS FOR CLEANING.

Cleaning the plant may be facilitated if the following suggestions are observed: It is well to have one end of the vat slightly lower than the other end, so that the ooze will run toward that point when the tub is being emptied. If the entire floor of the collecting pens is made of brick, cement, or boards, and inclines slightly toward one or two points, the yards may be more easily cleaned by means of a hose and

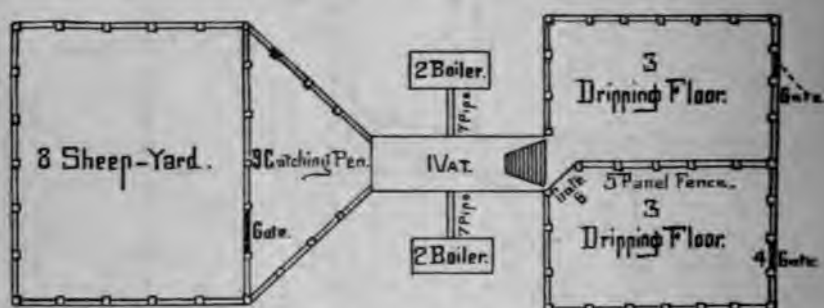


FIG. 34.—Ground plan of yards and vat. (Copied from Powers' *The American Merino*, 1887, p. 394.)

stream of water. If this plan is adopted there should be an upright baseboard or a solid wall of concrete or brick a few inches in height running around the edge of the entire pen. If there is direct sewer connection for the vat a trap or manhole should be made to catch the droppings and the tags of wool, otherwise the sewer pipe will become obstructed.

BOILING, INFUSING, AND SELLING TANKS.

The arrangement of the boiling tanks depends upon two factors in particular: First, upon the kind of dip used; second, upon the arrangement adopted for keeping the bath at the proper temperature.

In case a steam pipe is placed near the floor of the dipping vat in order to keep the ooze at its proper temperature while dipping, the vat itself may be used for heating water. Clear water is run into the vat and the steam turned on full force until the proper temperature is obtained. If a carbolic or a prepared tobacco dip is used, the material may then be mixed in the vat if desired. Even in this case, however, it is best to provide a separate boiling tank for heating and preparing fresh ooze to replace the dip as it is used up.

These boiling tubs may be made of wood or iron, according to the facilities at hand. If steam is to be had, the square or round wooden boiling tub may be used, and an open steam pipe run into it to heat the water. If the steam pipe can not be used, either in the vat or in

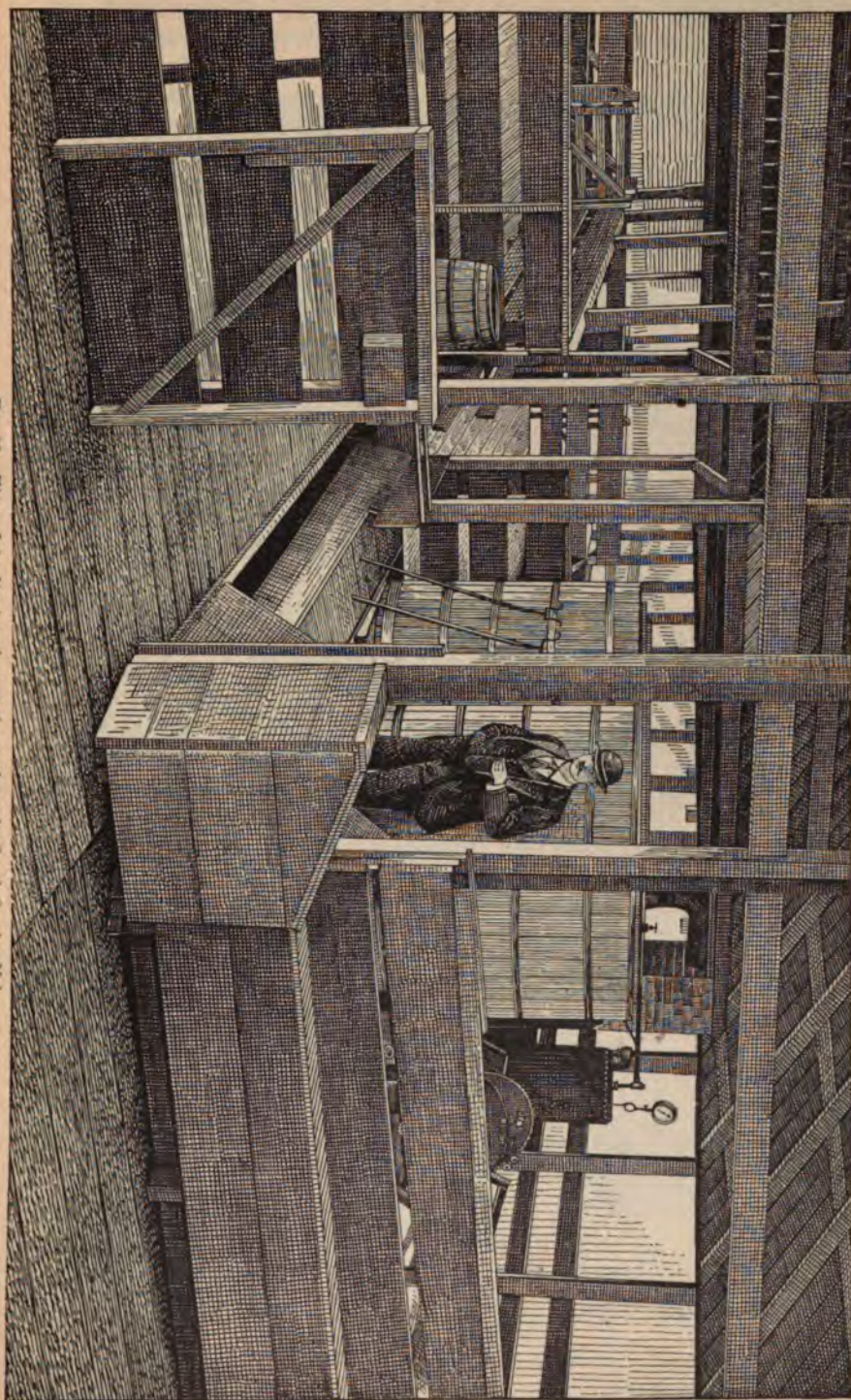


FIG. 35.—View of the dipping plant at the stock yards, South Omaha, Neb.

the boiling tanks, iron tanks should be provided. The iron tanks are set in brick or stone frames, with a fireplace below. It is best to have two tanks, each with a capacity of about 400 gallons.

If a homemade tobacco dip is prepared from the leaves there should also be provided two iron infusing caldrons, each with a cover and with a capacity of 80 to 120 gallons. The infusion is prepared in these smaller tanks, while the bulk of the water is heated in the boiling tanks or in the swim itself.

If a lime-and-sulphur dip is used it is absolutely necessary to provide some means for settling the mixture, in order that the bath may be free from sediment. This may be done in two ways. The better way is to have separate settling tubs provided with bungholes or pipes three or four inches from the bottom. After the mixture is thoroughly boiled it is pumped into the settling tubs and allowed to remain there until it is perfectly free from sediment; the clear liquid is then run into the dipping vat and diluted with warm water to the proper strength. Or the boiling tanks may also be used as settling vats. A pipe with elbow joint is run into the boiling tank three or four inches above the bottom; the opening of the pipe should point sidewise, not up. After boiling the proper length of time the fire is removed and the liquid allowed to stand until clear; only the clear ooze is drawn off, the sediment remaining on the floor of the boiling tank.

MEASURES.

The capacity of the vat should be marked at different depths. The capacity of the boilers should also be marked in the same way. If these are marked for every 100, 200, 300, or 500 gallons (according to the amount of dipping to be done), separate measuring tanks will be unnecessary. In case the tanks are not marked a separate measuring tank should be provided.

If a homemade tobacco dip or a lime-and-sulphur dip is used a set of scales is necessary. To guess at weights in mixing lime and sulphur may result in too strong a dip.

PUMPS.

A portable pump will be found of great use in filling and emptying tanks.

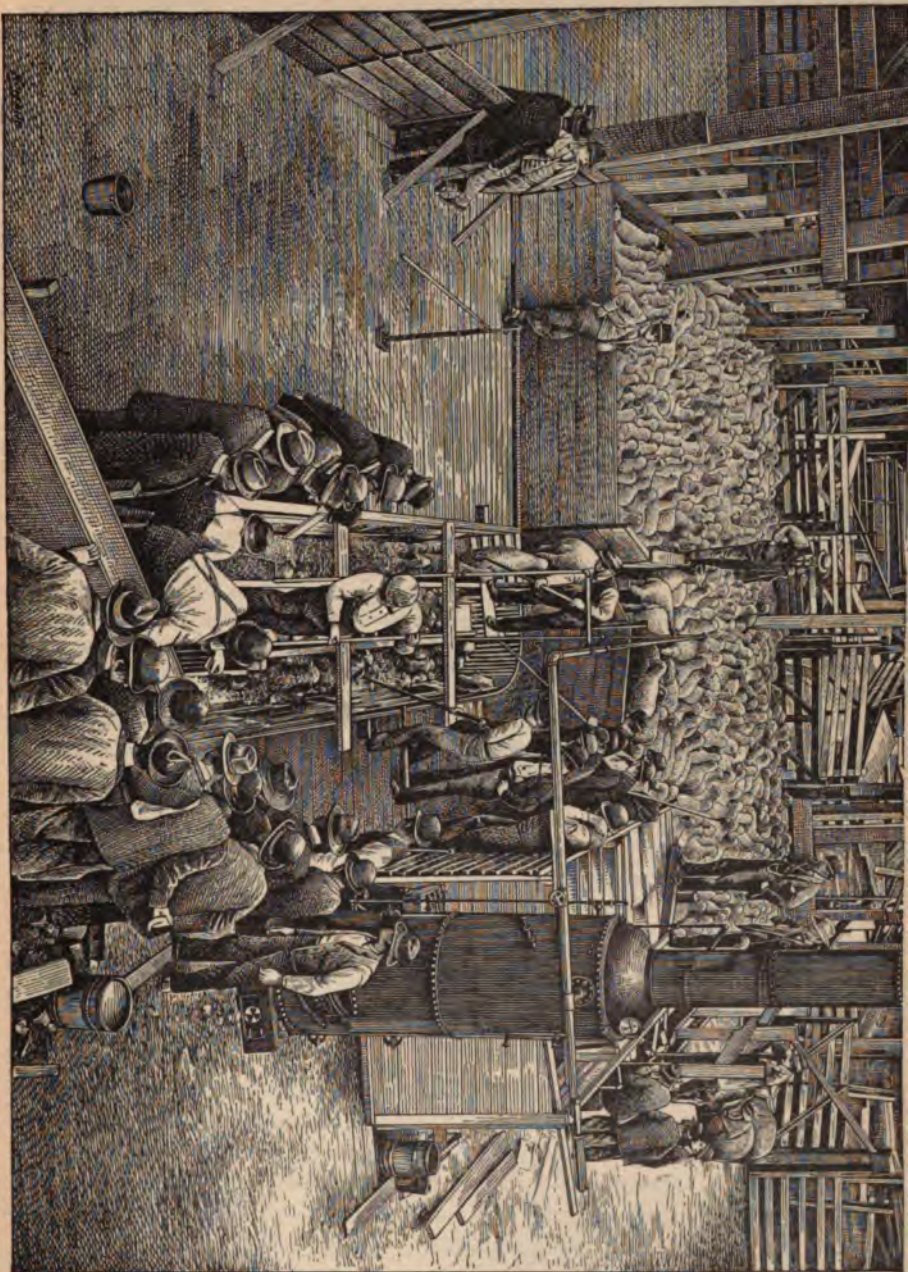


FIG. 36.—View of the dipping plant at the Union Stock Yards, Chicago, Ill. (This dipping plant, including vat, boiler, etc., cost about \$2,500.)

FEDERAL LAWS AND REGULATIONS RELATIVE TO SHEEP SCAB.

As the scab of the sheep is unquestionably a contagious disease, it is unlawful to ship sheep so affected from any State, Territory, or the District of Columbia into any other State, Territory, or the District of Columbia. The penalties for such shipment of diseased sheep are heavy, as will be seen from an examination of sections 6 and 7 of the act approved May 29, 1884, which are as follows:

SEC. 6. That no railroad company within the United States, or the owners or masters of any steam or sailing or other vessel or boat, shall receive for transportation or transport, from one State or Territory to another, or from any State into the District of Columbia, or from the District into any State, any live stock affected with any contagious, infectious, or communicable disease, and especially the disease known as pleuro-pneumonia; nor shall any person, company, or corporation deliver for such transportation to any railroad company, or master or owner of any boat or vessel, any live stock, knowing them to be affected with any contagious, infectious, or communicable disease; nor shall any person, company, or corporation drive on foot or transport in private conveyance from one State or Territory to another, or from any State into the District of Columbia, or from the District into any State, any live stock, knowing them to be affected with any contagious, infectious, or communicable disease, and especially the disease known as pleuro-pneumonia: *Provided*, That the so-called splenetic or Texas fever shall not be considered a contagious, infectious, or communicable disease within the meaning of sections four, five, six, and seven of this act, as to cattle being transported by rail to market for slaughter, when the same are unloaded only to be fed and watered in lots on the way thereto.

SEC. 7. That it shall be the duty of the Commissioner of Agriculture to notify, in writing, the proper officials or agents of any railroad, steamboat, or other transportation company doing business in or through any infected locality, and by publication in such newspapers as he may select, of the existence of said contagion; and any person or persons operating any such railroad, or master or owner of any boat or vessel, or owner or custodian of or person having control over such cattle or other live stock within such infected district, who shall knowingly violate the provisions of section six of this act, shall be guilty of a misdemeanor, and, upon conviction, shall be punished by a fine of not less than one hundred dollars nor more than five thousand dollars, or by imprisonment for not more than one year, or by both such fine and imprisonment.

The provisions of this statute are very specific and clear, and there can be no possible doubt of their application to the disease under consideration. Congress has, nevertheless, gone still further by way of emphasizing this application, and has particularly directed the attention of the Department of Agriculture to a few important diseases, including sheep scab, by the following clause, which has been repeated in the appropriation act for a number of years:

* * * and the Secretary of Agriculture is hereby authorized to use any part of this sum he may deem necessary or expedient, and in such manner as he may think

best, in the collection of information concerning live stock, dairy, and other animal products, and to prevent the spread of pleuro-pneumonia, tuberculosis, sheep scab, and other diseases of animals, and for this purpose to employ as many persons as he may deem necessary.

Acting in accordance with this legislation, the following orders have been made and promulgated by the Secretary of Agriculture:

REGULATIONS PROHIBITING THE TRANSPORTATION OF ANIMALS AFFECTED WITH HOG CHOLERA, TUBERCULOSIS, OR SHEEP SCAB.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,

Washington, D. C., December 13, 1895.

Notice is hereby given that under the law relating to control of contagious and infectious diseases of animals, the regulations of the Bureau of Animal Industry dated April 15, 1887, are hereby amended by additional section, as follows:

SEC. 15. Animals affected with hog cholera, tuberculosis, or sheep scab shall be considered animals affected with contagious or infectious diseases as designated by the law and the regulations of the Bureau of Animal Industry, and shall not enter into interstate trade nor be brought into contact with other animals intended for such trade. Such affected animals shall not be permitted to enter any stock yards or other places where animals are handled for interstate trade, and when so found at such places shall be condemned, tagged, and placed in quarantine by inspectors or employees of said Bureau until proper disposition is made of same.

Stock-yard companies, transportation companies, or others receiving or handling such diseased animals are hereby required to thoroughly disinfect such portions of their premises or property as contained such diseased animals, subject to the approval of the inspectors of said Bureau.

Such diseased animals so quarantined shall not be removed therefrom except by written permit of the inspector in charge. When such diseased animals are found, inspectors shall make careful inquiry as to shipper and owner of same, and transportation company handling same, for the purpose of instituting prosecution under the law provided in such cases.

All animals entering stock yards where inspection exists shall be carefully inspected and those affected with the contagious diseases above mentioned shall be condemned and tagged, and when so condemned shall not be shipped therefrom or enter into the interstate trade; and all violations of this regulation should be immediately reported to the Chief of the Bureau of Animal Industry for institution of prosecution according to law.

J. STERLING MORTON, Secretary.

(B. A. I. ORDER NO. 5.)

TRANSPORTATION OF SHEEP AFFECTED WITH SCABIES.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,

Washington, D. C., June 18, 1897.

To the Managers and Agents of Railroads and Transportation Companies of the United States, Stockmen, and Others:

In accordance with section 7 of the act of Congress approved May 29, 1884, entitled "An act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases among domestic animals," and of the act of Congress approved April 23, 1897, making appropriation for the Department of Agriculture for the fiscal year ending June 30, 1898, you are hereby notified that the contagious disease known as sheep scab, or scabies of sheep, exists among sheep in the United States, and that it is a violation of the law to receive for

transportation or transport any stock affected with said disease from one State or Territory to another, or from any State into the District of Columbia, or from the District into any State. It is also a violation of the law for any person, company, or corporation to deliver for such transportation to any railroad company, or master or owner of any boat or vessel, any sheep, knowing them to be affected with said disease; and it is also unlawful for any person, company, or corporation to drive on foot or transport in private conveyance from one State or Territory to another, or from any State into the District of Columbia, or from the District into any State, any sheep, knowing them to be affected with said disease. All transportation companies and individuals shipping, driving, or transporting sheep are requested to cooperate with this Department in enforcing the law for preventing the spread of the said disease. Inspectors of the Bureau of Animal Industry are directed to report all violations of this act which come to their attention.

In order to more effectually accomplish the object of the above-mentioned laws, it is hereby ordered that any railroad cars, boats, or other vehicles, which have been used in the transportation of sheep affected with said disease, shall be immediately cleaned and disinfected by the owners or by the transportation companies in whose possession said cars or vehicles may be at the time the animals are unloaded, by first removing all litter and manure which they contain, and then saturating the woodwork with a 5 per cent solution of crude carbolic acid in water. Inspectors of the Bureau of Animal Industry are directed to see that this order is carried into effect.

JAMES WILSON, *Secretary*.

NOTICE OF ENFORCEMENT OF THE LAW.

These orders constitute the notice as to the existence of the disease, and call the attention of transportation companies, stockmen, and others to the provisions of the law. Any one who violates this law or the regulations made in accordance therewith will be subject to the penalty, and can no longer plead ignorance or lack of notice. Owing to an insufficient number of inspectors during the past years, the Department has not been as active in seeking out and prosecuting offenders against this statute as the importance of the matter demands. There have undoubtedly been many shippers, as well as transportation companies, who have rendered themselves liable to prosecution and who have not been proceeded against, but it should not be concluded that, because the penalty has been escaped in a few instances, this immunity will continue. The inspection force is now competent to deal with this subject, and the Department of Agriculture will hereafter take such steps as may be required to stop the dissemination of this contagion through the channels of interstate commerce. In such action the Department will have the assistance and cooperation of all good citizens, and particularly of all of those who are interested in the sheep industry. There is probably no disease in this country, with the exception of hog cholera, which causes greater losses among the domestic animals than does sheep scab, and at the same time none which is so easily, cheaply, and certainly cured. It is, therefore, discreditable to the intelligence and practical qualities of our people that this contagion should still be rampant and continually distributed through the channels of commerce.

All sheep owners who expect to ship or drive their sheep across State

lines should assure themselves before the animals are started that scab does not exist among them. In case symptoms of the disease are discovered, the animals should be dipped and cured before they leave the farm. The information in this bulletin is sufficient to enable anyone to cure this disease with a minimum of trouble and expense. There will hereafter be no excuse for those who claim that they are unacquainted with the nature of the disease or with the methods of treatment.

EFFECT OF MEAT-INSPECTION REGULATIONS.

Sheep suffering from scab are affected by the meat-inspection law and regulations, as well as by those mentioned above. Section 6 of these regulations provides as follows:

6. The inspector in charge of said establishment shall carefully inspect all animals in the pens of said establishment about to be slaughtered, and no animal shall be allowed to pass to the slaughtering room until it has been so inspected. All animals found on either ante-mortem or post-mortem examination to be affected as follows are to be condemned and the carcasses thereof treated as indicated in section 7:

- (1) Hog cholera.
- (2) Swine plague.
- (3) Charbon, or anthrax.
- (4) Rabies.
- (5) Malignant epizootic catarrh.
- (6) Pyæmia and septicæmia.
- (7) Mange, or scab, in advanced stages.
- (8) Advanced stages of actinomycosis, or lumpy jaw.
- (9) Inflammation of the lungs, the intestines, or the peritoneum.
- (10) Texas fever.
- (11) Extensive or generalized tuberculosis.
- (12) Animals in an advanced state of pregnancy or which have recently given birth to young.
- (13) Any disease or injury causing elevation of temperature or affecting the system of the animal to a degree which would make the flesh unfit for human food.

Any organ or part of a carcass which is badly bruised or affected by tuberculosis, actinomycosis, cancer, abscess, suppurating sore, or tapeworm cysts must be condemned.

Instructions have been issued to inspectors to rigidly enforce these regulations. Sheep in an advanced stage of scab are feverish and unfit for food, and their carcasses will be condemned. Shippers who forward animals for slaughter in this condition will be likely to lose heavily upon them, as they will be subject to quarantine and condemnation. This is an additional and important reason for curing affected animals before they leave the feeding place.

Failure to observe the laws and regulations as they relate to this disease will in many cases result in hardship and loss. In order to avoid such unpleasant results so far as possible and to facilitate the control of the disease this article has been prepared. It is believed that there has been brought together herein all the information needed by the sheep owner to successfully combat this scourge of American flocks.

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In order to more effectually accomplish the object of the above-mentioned laws, it is hereby ordered that any railroad cars, boats, or other vehicles, which have been used in the transportation of sheep affected with said disease, shall be immediately cleaned and disinfected by the owners or by the transportation companies in whose possession said cars or vehicles may be at the time the animals are unloaded, by first removing all litter and manure which they contain, and then saturating the wood-work with a 5 per cent solution of crude carbolic acid in water. Inspectors of the Bureau of Animal Industry are directed to see that this order is carried into effect.

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BULLETIN No. 21—(REVISED).

(B. A. I. 142.)

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

SHEEP SCAB:

ITS NATURE AND TREATMENT.

BY

D. E. SALMON, D. V. M.,

Chief of Bureau of Animal Industry,

AND

CH. WARDELL STILES, Ph. D.,

Zoologist of the Bureau.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.

1900.



LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., May 1, 1900.

SIR: I have the honor to transmit herewith, for publication as a bulletin of this Bureau, a discussion of "Sheep Scab: Its Nature and Treatment." The disease known as scab is one of the most serious drawbacks to the sheep industry and results in enormous financial losses. Yet, despite its insidious nature, its ease of transmission, its severe effects, and its prevalence in certain localities, it is a disease which yields readily to proper treatment. If all of the sheep owners of the country would dip regularly and thoroughly, there is no reason why this scourge should not be totally eradicated from the United States. There should be stringent scab laws in every State, with State inspectors to see that those laws are carried out.

The sheep raisers of this country are intelligent and progressive men, and most of them fully recognize the necessity of combining to eradicate this disease. In many cases, however, more particularly among owners of small flocks, there are many erroneous ideas prevalent regarding the exact nature of the disease and the methods by which it may be eradicated. It is to meet the demand for exact information on this subject that this bulletin has been prepared. In it will be found a description of the various kinds of scab, references to conditions which may be mistaken for scab, a description of various kinds of dipping plants suitable for use on small and on large farms, directions for preparing certain homemade dips, and directions for dipping. The investigation of various kinds of dips will be continued by this Bureau, and supplementary circulars will be published if necessary. Some slight inaccuracies which occurred in the original publication submitted March 15, 1898, have been corrected in the present edition.

In the preparation of the bulletin the writers have received valuable assistance from Dr. Schroeder, Director of our Experiment Station.

Respectfully,

D. E. SALMON,
Chief of Bureau of Animal Industry.

HON. JAMES WILSON,
Secretary.



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SHEEP SCAB: ITS NATURE AND TREATMENT.

HISTORICAL INTRODUCTION.

The disease commonly called sheep scab is the mange, or scabies, of the sheep. It is a contagious skin disease caused by a parasitic mite. This disease is one of the oldest known, most prevalent, and most injurious maladies which affects this species of animals. It has been well known for many centuries, and references to it are found in the earlier writings, including the Bible, where we find, in Leviticus, xxii: 22, the use of scabbed sheep forbidden in sacrifices. Some think that the mite which causes the disease was known to Aristotle, 322 B. C.; but it appears that Wichmann, writing in 1786, was one of the first authors of modern times to suspect that sheep scab was of the same nature as the scabies of man. Wichmann held the erroneous view, however, that both diseases were produced by the same parasite.

The prevailing opinion concerning scab prior to and during the first years of the present century was that it was caused by some special condition of the sheep's system, a "humor of the blood," which led to a skin eruption. The parasites were in some cases known and recognized, but they were supposed to be either an accidental occurrence or to have arisen by spontaneous generation as a result of the disease, and because the affected skin offered conditions favorable to their development and existence.

As a result of diligent research, certain investigators reached the conclusion that the malady was due directly to the mites which were found inhabiting the diseased parts of the skin. Their opinion was not at once adopted, however, but, on the contrary, met with strong opposition from those who held that scab was due to a diseased condition of the blood and from others who held a modified view to the effect that the mites carried poisonous or diseased material from one animal to another and in that manner communicated the disease. The errors and uncertainties which came down to us through centuries of controversy were finally and for all time dispelled by conclusive experiments upon animals made during the first half of this century. It was shown that scab does not develop and can not be produced without the parasites. The complete life cycle of the mites was studied and demonstrated from the eggs to the adult parasites. It was shown that mites are always the offspring of ancestors, the same as are the larger animals, and it has in later years come to be admitted that there is no such thing known

as spontaneous generation of any living thing under any circumstances. The demonstration was repeatedly made that the disease always developed if mites were taken from diseased sheep and placed upon healthy ones, and that diseases of the skin resembling scab are not contagious unless the mite is present.

Questions are still frequently asked, by persons not conversant with the investigations of the subject, as to whether the scab is the cause of the mite or the mite is the cause of the scab, and also whether the disease can develop without the presence of the scab mite. The investigations which have been referred to answer these questions and also show that the treatment must consist in external applications for the destruction of the parasites and not internal remedies to "purify the blood."

Is scab hereditary?—An impression has arisen among some sheep raisers that scab is hereditary. This impression is, however, erroneous. Scab is no more hereditary than are sheep ticks or sheep lice, for the parasites which cause it live on the external surface of the body and do not reach the womb. It is possible, however, for a lamb to become infected from a scabby mother at the moment of birth or immediately after. Lambs are occasionally born with white spots on their skin, and this possibly has given rise to the idea that scab is hereditary.

LOSSES CAUSED BY SCAB.

Losses in home industry.—The losses from sheep scab have been and are still very severe in most sheep-raising countries. They are due to the shedding of the wool, the loss of condition, and the death of the sheep.

Although laws were made for the control of the disease as early as the beginning of the eleventh century, general ignorance in regard to its nature and proper treatment has prevented the successful administration of such laws even to the present day. The disease exists in most of the countries of Europe, and also in Asia and Africa, and until recently in Australia. Most civilized countries now control the disease to a certain extent, and limit the losses by the enforcement of stringent sanitary regulations; but the extent of its prevalence is nevertheless surprising. It is a disease not difficult to cure and eradicate, and an accurate knowledge of its characteristics with attention to details are all that is needed to secure this result.

In the United States some sections have been overrun with sheep scab, and many persons engaged in the sheep industry have been forced to forsake it because of their losses from this disease. It is probable that in its destruction of invested capital sheep scab is second only to hog cholera among our animal diseases. The large flocks of the Plains and Rocky Mountain region and the feeding stations farther east have suffered severely and are constantly sending diseased animals to the great stock yards of this country. As a consequence of this marketing of affected sheep, the stock yards are continually infected, and any

sheep purchased in these markets are, unless properly dipped, likely to develop the disease after they are taken to the country for feeding or breeding. There is in this way a constant distribution of the contagion, and thousands of persons who know little of its nature or the proper methods of curing it find that they have introduced it upon their premises.

Losses in export trade.—In addition to the direct losses in wool, in flesh, and in the lives of our sheep, we have suffered immensely in our foreign trade because of the prevalence of this disease. Great Britain appears to have been the first country to prohibit live sheep coming from the United States, by an order issued in 1879. Upon representations that there was no foot-and-mouth disease in the United States this order was rescinded in 1892, but only to be again enforced in 1896 on account of the many scabby sheep sent abroad by our exporters. Our sheep are consequently slaughtered on the docks where landed, the market being restricted and the prices much less favorable than would otherwise be obtained. The markets of Continental Europe have been entirely closed to American sheep, as even the privilege of slaughtering at the landing places is denied. For a long time it was impossible to send our pure-bred sheep to Australia, where there is a demand for them for breeding purposes, because the Australian law required them to be transshipped and quarantined in British ports, and the British authorities declined to grant this privilege. Arrangements have since been made for the direct shipment of sheep to Australia, if accompanied by the certificate of a veterinarian appointed by the Australian authorities.

On the whole, it is seen that the existence of this disease in our flocks has prevented the development of our export trade in many directions, and has caused no end of trouble and loss to our exporters.

CAUSE OF SCAB.

Sheep scab is a strictly contagious disease.

Common sort.—Common sheep scab is caused by that species of mites technically known as *Psoroptes communis*.¹ Parasites of this species cause scab in horses, cattle, sheep, goats, and rabbits; but for each of these species of animals there appears to be a distinct variety of this parasite. Although it is more or less difficult to distinguish between these varieties, they differ somewhat in size, and it is found that the *Psoroptes communis* of the sheep does not cause scab of the horse, ox, or rabbit; nor, on the other hand, does the *Psoroptes communis* of the horse, ox, or rabbit cause scab of the sheep. Natural-

¹The technical term *Psoroptes* is derived from the Greek, and means that the mites hide under the crusts. The parasite is sometimes called *Dermatocoptes*, which means that the mites wound the skin. A third name, *Dermatodectes*, indicates that the mites bite the skin.

ists, therefore, distinguish the parasite of sheep scab by the name *Psoroptes communis* var. *ovis*.¹

The parasite of this disease is one of the larger mites, and is quite easily seen with the naked eye. The adult female is about one-fortieth inch long and one-sixtieth inch broad; the male is one-fiftieth inch long and one-eightieth inch broad. These mites are discovered more readily and more clearly on a dark than on a light background, and for that reason the crusts from the affected skin are often placed upon black paper and kept in the sunshine for a few minutes in order to reveal the parasites crawling about.

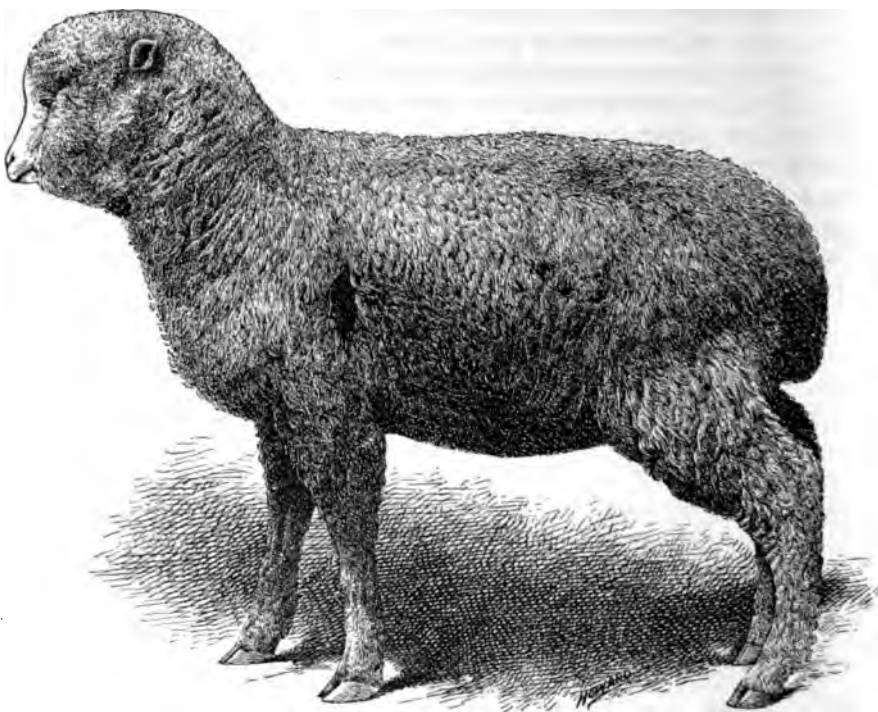


FIG. 1.—A comparatively early case of common scab, showing a bare spot and a tagging of the wool.

The psoropt inhabits the regions on the surface of the body which are most thickly covered with wool; that is, the back, the sides, the rump, and the shoulders. It is the most serious in its effects upon sheep of any of the parasitic mites, and it is the cause of the true body scab.

Other forms.—Sheep are also affected with three other forms of scab, likewise caused by parasitic mites. One of these is the sarcoptic scab (head scab, or black muzzle), which is limited almost entirely to the head, and is caused by the mite known as the *Sarcoptes*

¹ Var. is the abbreviation of the Latin word *varietas*, meaning variety.



FIG. 1.—A SLIGHTLY ADVANCED CASE OF COMMON SCAB.

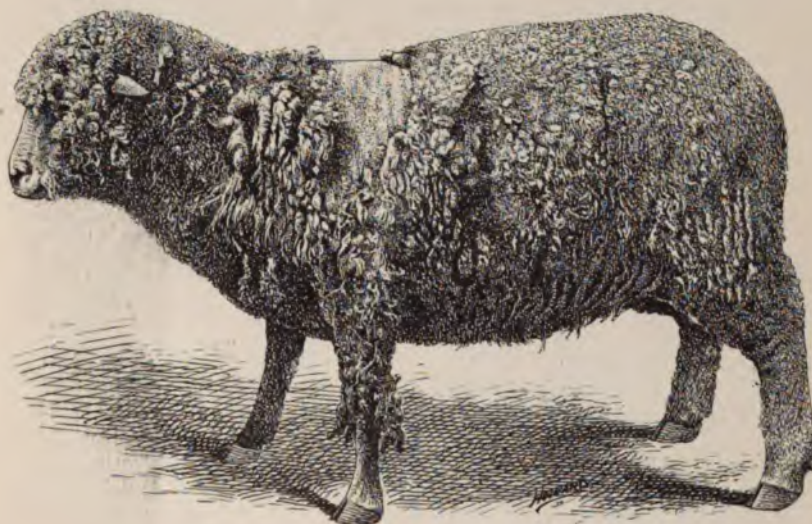


FIG. 2.—A MORE ADVANCED CASE OF COMMON SCAB.



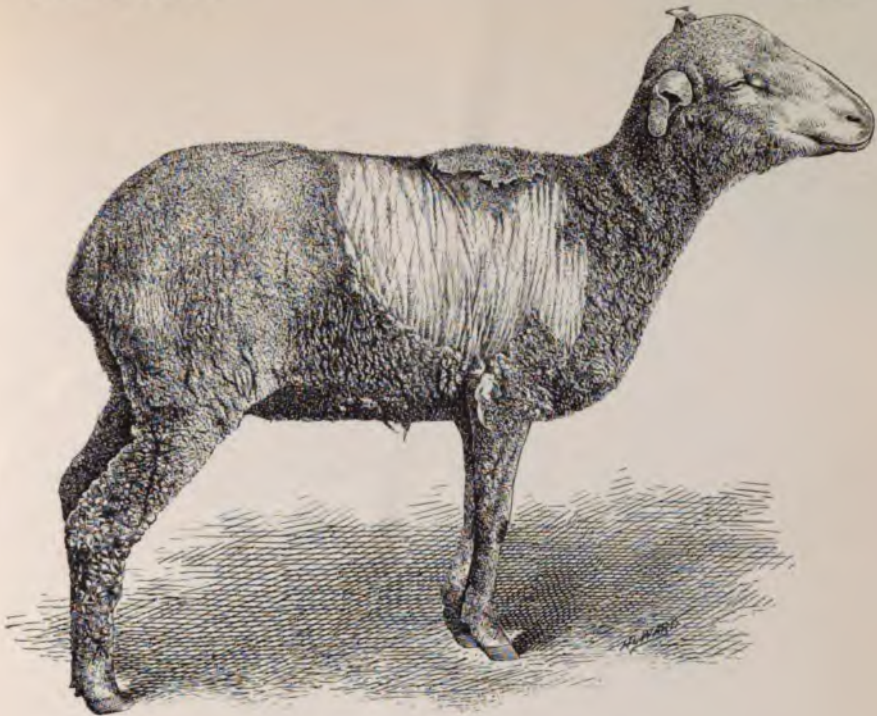
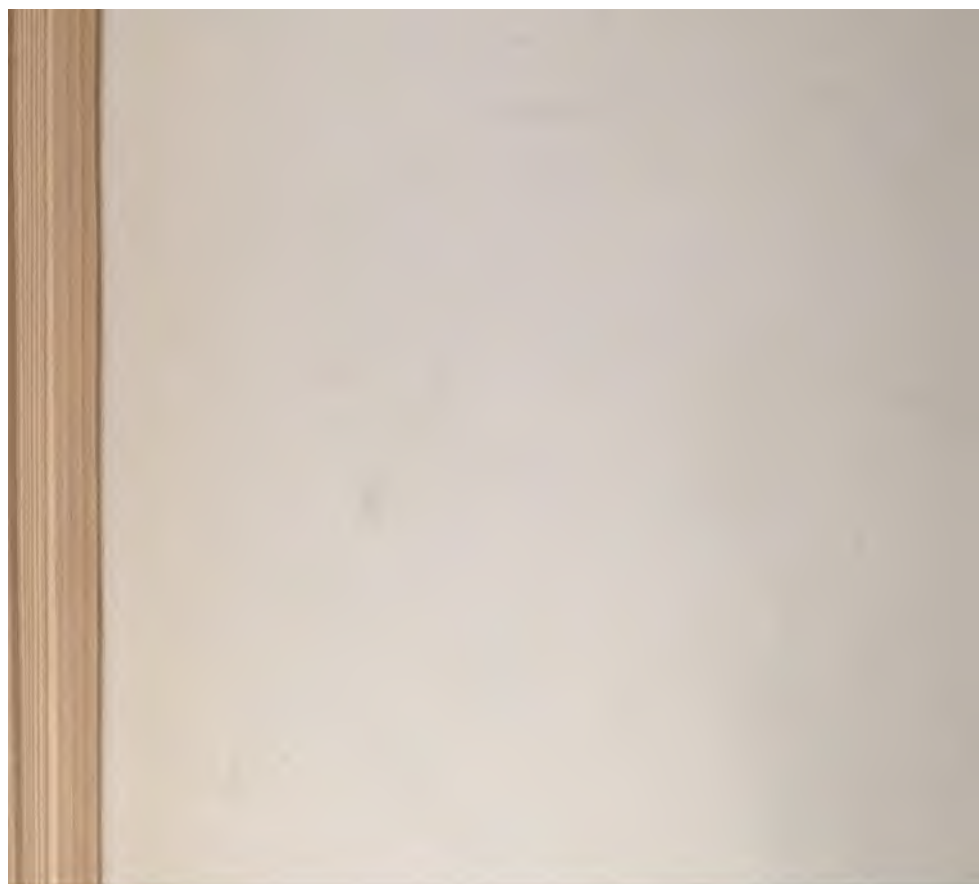


FIG. 3.—A SHORN SHEEP WITH LARGE BARE AREA DUE TO SCAB.



FIG. 4.—AN ADVANCED CASE OF COMMON SCAB.



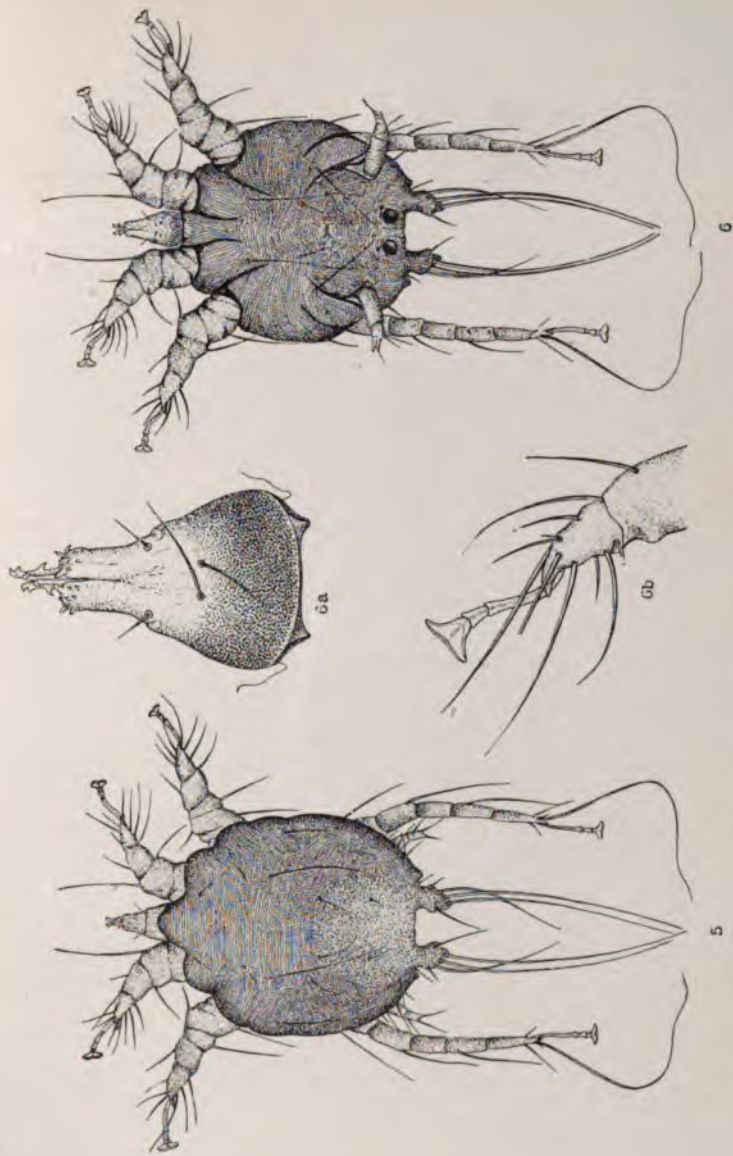
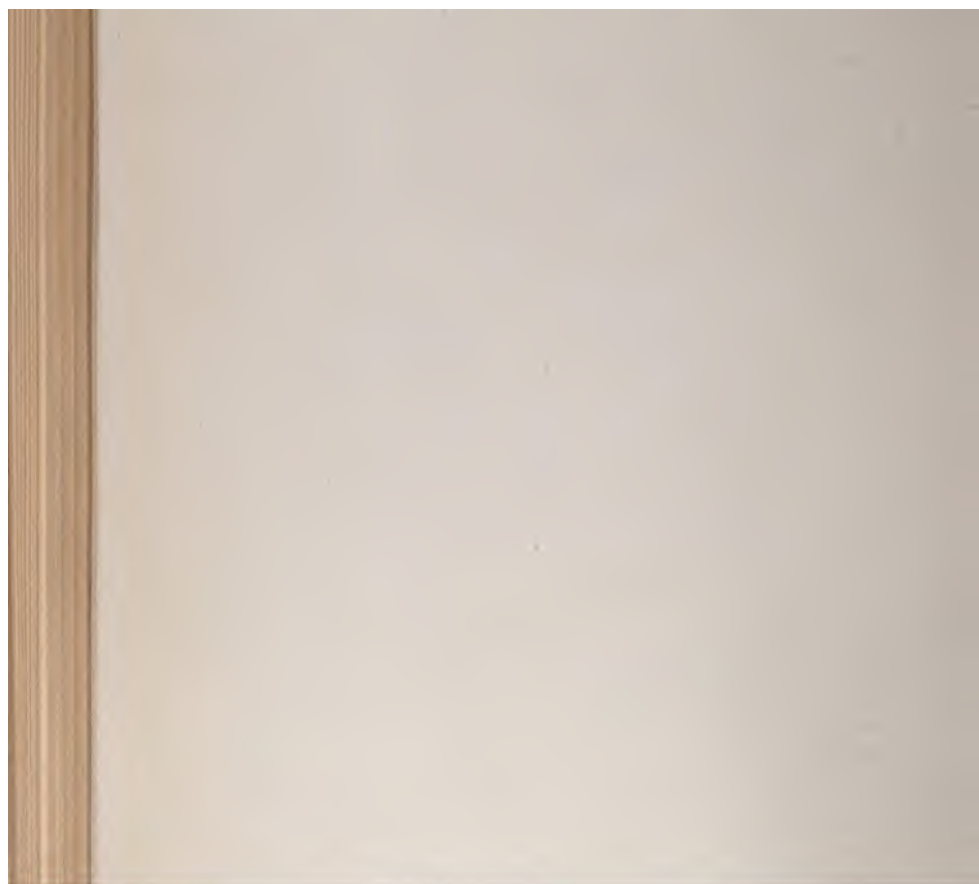


FIG. 5.—ADULT MALE PARASITE OF COMMON SHEEP SCAB, DORSAL VIEW. FIG. 6.—VENTRAL VIEW OF SAME. FIG. 6 A.—HEAD OF FEMALE. FIG. 6 B.—LEG OF FEMALE. (ALL GREATLY ENLARGED.)



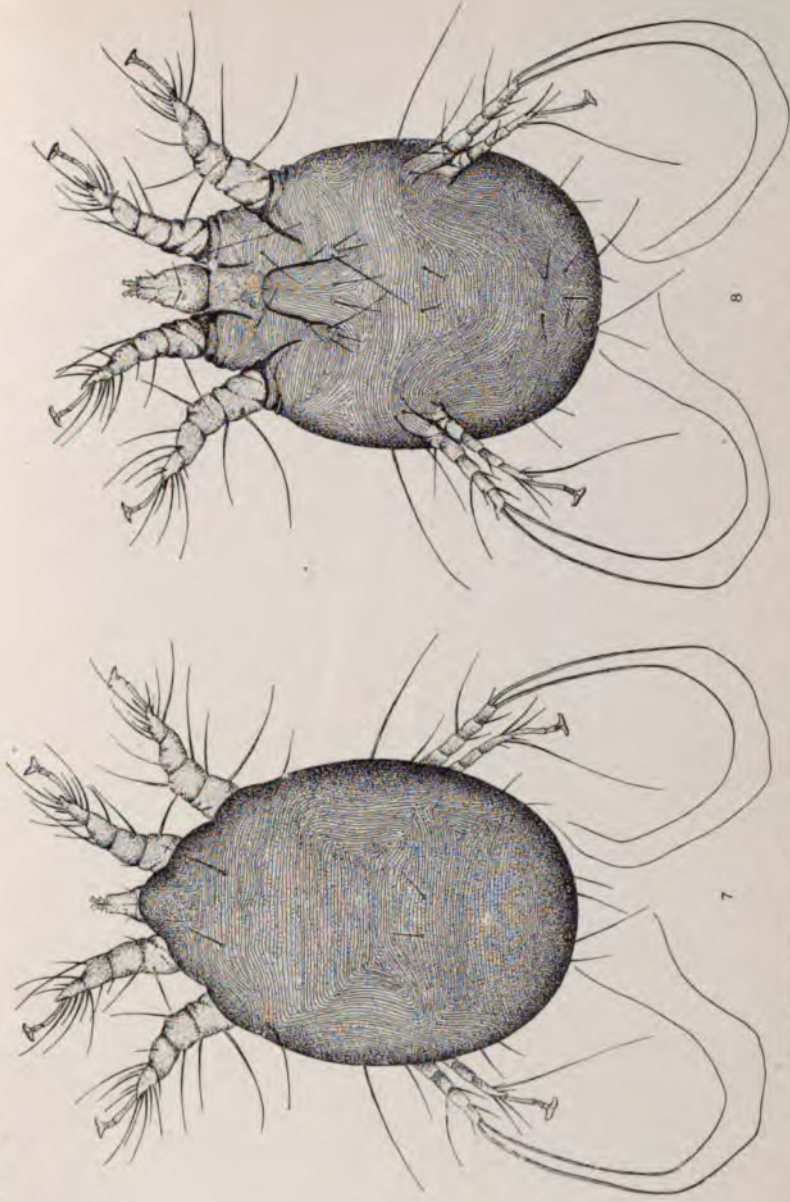
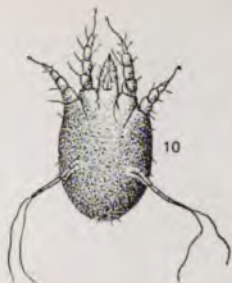


FIG. 7. - ADULT FEMALE PARASITE OF COMMON SHEEP SCAB, DORSAL VIEW. FIG. 8. - VENTRAL VIEW OF SAME. (BOTH GREATLY ENLARGED.)

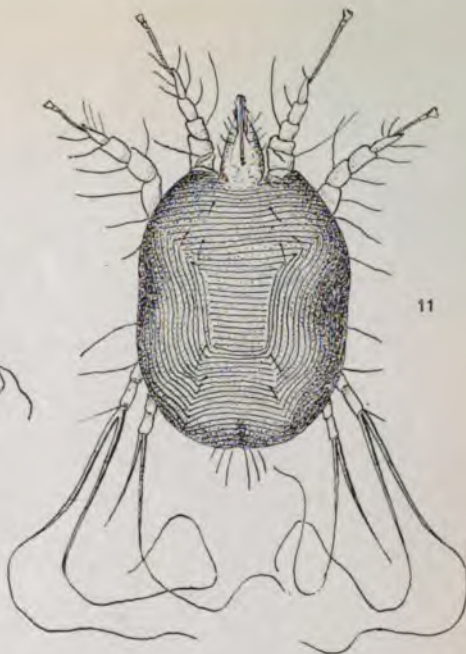




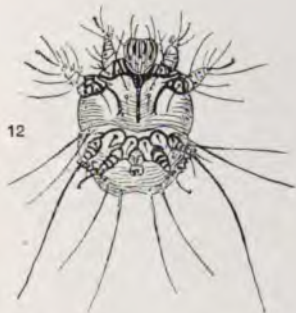
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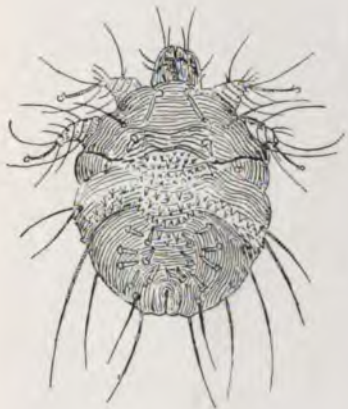
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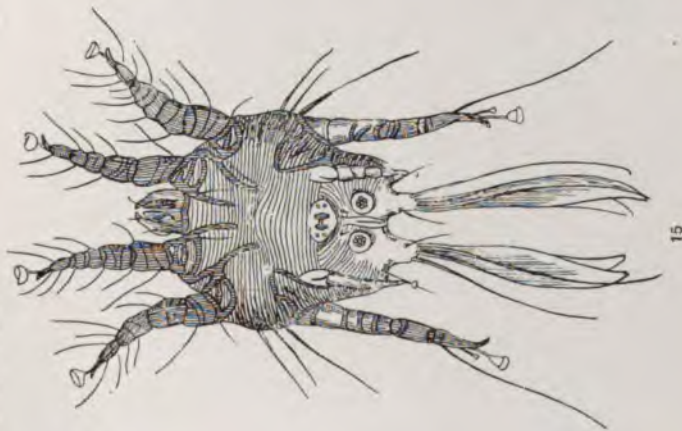
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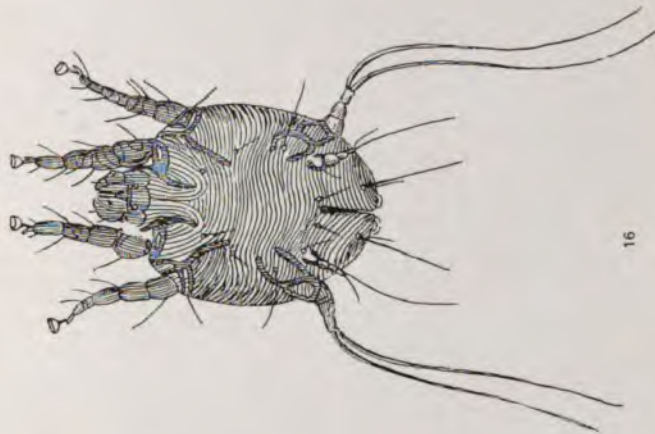
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FIG. 9.—EGG OF MITE WHICH CAUSES COMMON SHEEP SCAB. FIG. 10.—SIX-LEGGED STAGE OF SHEEP SCAB MITE.
 FIG. 11.—YOUNG FEMALE BEFORE MOULTING FOR THE LAST TIME, DORSAL VIEW. FIG. 12.—ADULT MALE
 PARASITE OF SARCOPTIC SCABIES OF MAN (THE CORRESPONDING PARASITE OF SHEEP IS VERY SIMILAR),
 VENTRAL VIEW, X 250 (AFTER BLANCHARD). FIG. 13.—ADULT FEMALE PARASITE OF SARCOPTIC SCABIES,
 DORSAL VIEW, X 250 (AFTER BLANCHARD). FIG. 14.—SAME, VENTRAL VIEW (AFTER BLANCHARD). (ALL
 GREATLY ENLARGED.)

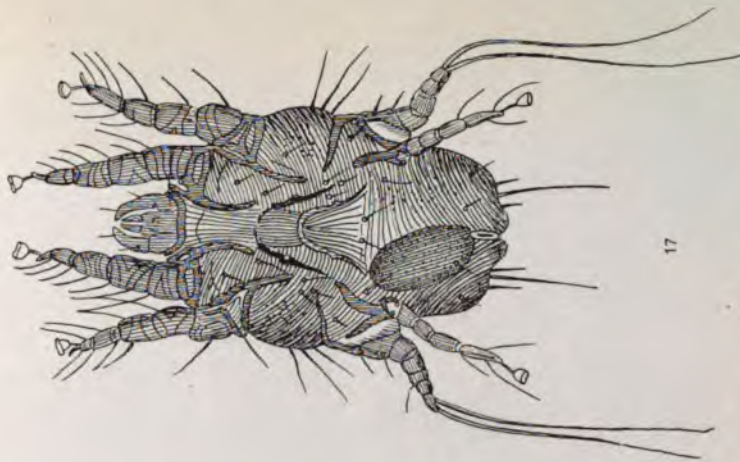




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FIG. 15.—ADULT MALE PARASITE OF CHORIOPTIC SCABIES OF THE HORSE (THE CORRESPONDING PARASITE OF SHEEP IS VERY SIMILAR), VENTRAL VIEW. FIG. 16.—YOUNG FEMALE PARASITE OF CHORIOPTIC SCABIES, VENTRAL VIEW. FIG. 17.—ADULT FEMALE PARASITE OF CHORIOPTIC SCABIES WITH EGG, VENTRAL VIEW. (ALL X 100; AFTER NEUMANN.)

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scabiei var. *ovis*.¹ The second is the symbiotic scab (foot scab), which affects the limbs, scrotum, and udder, and is caused by the *Chorioptes communis* var. *ovis*.² Lastly may be mentioned an extremely rare affection, the so-called follicular, or demodectic, scab, affecting the eyelids, caused by a mite known as *Demodex folliculorum* var. *ovis*.³

The sarcoptic, symbiotic, and demodectic forms of scab are with sheep mild diseases compared with common scab, and appear to be rather rare.

DESCRIPTION OF SHEEP SCAB.

(1) COMMON SCAB, BODY SCAB, OR PSOROPTIC SCAB.

Although the symptoms of common scab are familiar to most farmers, they will here be briefly reviewed.

The mites of common, or body, scab—that is, the *Psoroptes*—prick the skin of the animal to obtain their food, and probably insert a poisonous saliva in the wound. Their bites are followed by intense itching, with irritation, formation of papules, inflammation, exudation of serum, and the formation of crusts, or scabs, under and near the edge of which the parasites live. As the parasites multiply they seek the more healthy parts, spreading from the edges of the scab already formed, thus extending the disease. The sheep are restless; they scratch and bite themselves, and rub against posts, fences, stones, or against other members of the flock. This irritation is particularly noticeable after the animals have been driven, for the itching is more intense when the sheep become heated. The changes in the skin naturally result in a falling of the wool; at first slender “tags” are noticed; the fleece assumes the condition known as “flowering;” it looks tufty or matted, and the sheep pulls out portions with its mouth, or leaves tags on the objects against which it rubs. Scabs fall and are replaced by thicker and more adherent crusts. The skin finally becomes more or less bare, parchment-like, greatly thickened, furrowed, and bleeding in the cracks. With shorn sheep especially a thick, dry, parchment-like crust covers the greatly tumified skin. Ewes may abort or bear weak lambs.

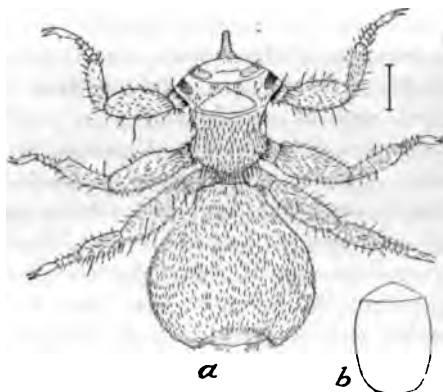


FIG. 2.—Adult sheep tick (a) and puparium (b) (*Melophagus ovinus*). Enlarged. (After Osborn, 1896; Bul. No. 5, Div. Entomology, Dept. Agr.)

¹ *Sarcoptes*, from the Greek, means that the mites wound the flesh.

² *Chorioptes* signifies that the mites hide in the skin. Another name, *Symbiotes*, signifies that a number of the mites live together; and a third name, *Dermatophagus*, means that the mites eat the skin.

³ *Demodex* signifies that the mites have a worm-like body.

Parts of body affected.—When sheep are kept in large numbers the chances for infection are naturally greater, and the disease may begin on almost any part of the body. Generally, however, it affects the parts which are covered with wool. When the sheep are fat and the wool has a large amount of yolk, the progress of the disease may be slow; usually beginning on the upper part of the body, withers, and back, it extends slowly, but none the less surely and in ever-increasing areas, to the neck, sides, flanks, rump, etc. In two or three months the entire body may be affected.

Contagion.—Common scab is exceedingly contagious from one sheep to another, and may in some cases show itself within about a week after healthy sheep have been exposed to infection. The contagion may be direct, by contact of one sheep with another; or indirect, from tags of wool, or from fences, posts, etc., against which scabby sheep have rubbed, or from the places where the sheep have been "bedded down." One attack of scab does not protect sheep from later attacks. Transmitted to man, sheep scab may produce a slight spot on the skin, a point which is sometimes taken advantage of for the purpose of diagnosis. In case of suspected scab, one of the crusts is bound lightly on the arm. After a short time an itching sensation is felt and the mites are found on the skin. Transmitted to horses, cattle, or goats, common sheep scab fails to develop.

Chances for recovery.—Cases of apparent spontaneous recovery are rare. Usually when proper methods of treatment are not adopted the disease increases, leads to anæmia, emaciation, exhaustion, and death, and may result in a loss of from 10 to 80 per cent of the flock. Scab is favored by seasons when the wool is longest, and by huddling or overcrowding the animals; also race, energy, temperament, age, state of health, length, fineness, and abundance of wool, and the hygienic conditions of the surroundings influence the course and termination of the disease. Young, weak, closely inbred animals, and those with long, coarse wool will most quickly succumb. Unhealthy localities, damp climate, and poorly ventilated sheds favor the disease. Pure or mixed Merino sheep succumb sooner than certain other breeds. The mortality varies according to conditions, but is highest in autumn and winter. When owners are careless the death rate may be very high; if untreated the sheep may die in two to three months. Hygienic conditions, good food, and cool dry atmosphere tend to check the disease. Sheep sheds should accordingly be well ventilated and open to light and sunshine. With proper attention to hygienic conditions and thorough dipping, a positive cure can be guaranteed.

Vitality of the parasite.—Taken from the sheep, the mites possess a remarkable vitality. It is generally stated that, kept at a moderate temperature on portions of scab, the adults may live from four to twenty days, but they will occasionally live much longer; cases are on record where they have lived three, four, or even six weeks when sepa-

rated from sheep; if the atmosphere is dry they will generally die in about fifteen days; but death is often only apparent, for the mites may sometimes be revived by warmth and moisture even after six or eight weeks; the fecundated females are especially tenacious of life. Various rather contradictory statements may be found regarding their resistance to cold: Krogmann states that they may live at a temperature of minus 10° C. (+14° F.) for twenty-eight days; other authors claim that the mites die in two hours at 47° F.; still other authors, that they die at 50° C. (122° F.). They are said to have been kept alive in cold water for six days and in warm water for ten days. Several authors admit, however, that the parasites are usually killed by a soaking rain; though it is claimed that in damp, dark stables they "may live for months."

Experience has shown that in some cases apparently healthy sheep have become infected in places where no sheep have been kept for four, eight, twelve, or even twenty-four months. The conditions underlying this infection are not thoroughly understood. Possibly some of the eggs have retained their vitality a long time and then hatched out; possibly the vitality of the fecundated female has also played a rôle; while it is not at all improbable that an entirely new infection has accidentally been introduced by birds or other animals. Certain authors of high standing scout the idea that birds can introduce an infection of scab, but there is no reason why birds should not do this, and there are some reasons for believing that they do. It has been noticed on the Experiment Station of the Bureau, for instance, that crows delight in perching on the backs of scabby sheep and picking at the scab; while so doing it is only natural that small tags of wool would adhere to their feet, and thus scatter scab. The fact that snails cling to birds' feet and are carried long distances is too well established to need discussion, and it is very probable that many of the cases where sheep are supposed to have become infected with scab on pastures which have not been occupied for one or two years are in reality cases of fresh infection by means of birds. From the data at hand, while it may be admitted that in some cases, under favorable conditions, the mites may live from spring to fall, it is scarcely within the limits of probability that either the scab mites or their eggs will live through a winter when separated from the sheep and exposed to the elements.

All matters connected with the vitality of the scab mite have an important bearing in explaining cases of indirect infection on roads over which scabby sheep have been driven, or in fields and sheds where they have been kept. From the facts now at our disposal we can lay down the following important rules:

(1) Scabby sheep should never be driven upon a public road; (2) sheds in which scabby sheep have been kept should be thoroughly cleaned, disinfected, and aired, and should be left unused for *at least four weeks* (better two months) before clean sheep are placed in them;

(3) fields in which scabby sheep have been kept should stand vacant at least four weeks (better six or eight) before being used for clean sheep; (4) a drenching rain will frequently serve to disinfect a pasture, but it is well to whitewash the posts against which scabby sheep have rubbed. Even after observing the precautions here given it is not possible to absolutely guarantee that there will be no reinfection, but the probabilities are against it.

Life history of the parasite.—A study of the life history of the scab parasite is necessary in order to determine several important points of practical value, such as the proper time for the second dipping, etc.

The female mite lays about 15 to 24 eggs on the skin, or fastened to the wool near the skin; a six-legged larva is hatched; these larvæ cast their skin and become mature; the mites pair and the females lay their eggs, after which they die. The exact number of days required for each stage varies somewhat, according to the writings of different authors, a fact which is probably to be explained by individual variation, and by the conditions under which the observations and experiments were made. Thus Gerlach, in his well-known work (1857), estimates about fourteen to fifteen days as the period required for a generation of mites from the time of pairing to the maturity of the next generation. He divides this time as follows: Under ordinary conditions the eggs hatch in three to four days, although two authors allow ten to eleven days for the egg stage; three or four days after birth the six-legged larvæ moult and the fourth pair of legs appears; this fourth pair is always present when the mites are two-thirds the size of the adults; when 7 to 8 days old the mites are mature and ready to pair; several (three or four) days are allowed for pairing; another generation of eggs may be laid fourteen to fifteen days after the laying of the first generation of eggs. Without going into all of the other observations on these points, it may be remarked that the eggs may not hatch for six or seven days; the six-legged larvæ may moult when three to four days old, and become mature; after pairing a second moult takes place, lasting four to five days; a third moult follows immediately, then eggs are laid and the adults die; in some cases there is a fourth moult, but apparently without any further production of eggs. Accepting Gerlach's estimate of fifteen days as an average for each generation of 10 females and 5 males, in three months' time the sixth generation would appear and consist of about 1,000,000 females and 500,000 males.

Several practical lessons are to be drawn from these figures: First, it is seen that the parasites increase very rapidly, so that if scab is discovered in a flock, the diseased sheep should immediately be isolated; second, if new sheep are placed in a flock, they should either first be dipped, as a precautionary measure, or they should at least be kept separate for several weeks to see whether scab develops; third, since the chances for infection are very great, the entire flock should be treated, even in case scab is found only in one or two animals; fourth,

as dipping is not certain to kill the eggs, the sheep should be dipped a second time, the time being selected between the moment of the hatching of eggs and the moment the next generation of eggs is laid. As eggs may hatch between three and seven, possibly ten or eleven, days, and as fourteen to fifteen days are required for the entire cycle, the second dipping should take place after the seventh day, but before the fourteenth day; allowing for individual variation and variation of conditions, the tenth, eleventh, or twelfth day will be the best time to repeat the dipping.

(2) HEAD SCAB, BLACK MUZZLE, OR SARCOPTIC SCAB.

Head scab is less frequent and less important than body scab. No case of it has ever been reported by the inspectors of this Bureau, and many extensive sheep breeders and professional sheep dippers state that they have never heard of a case.

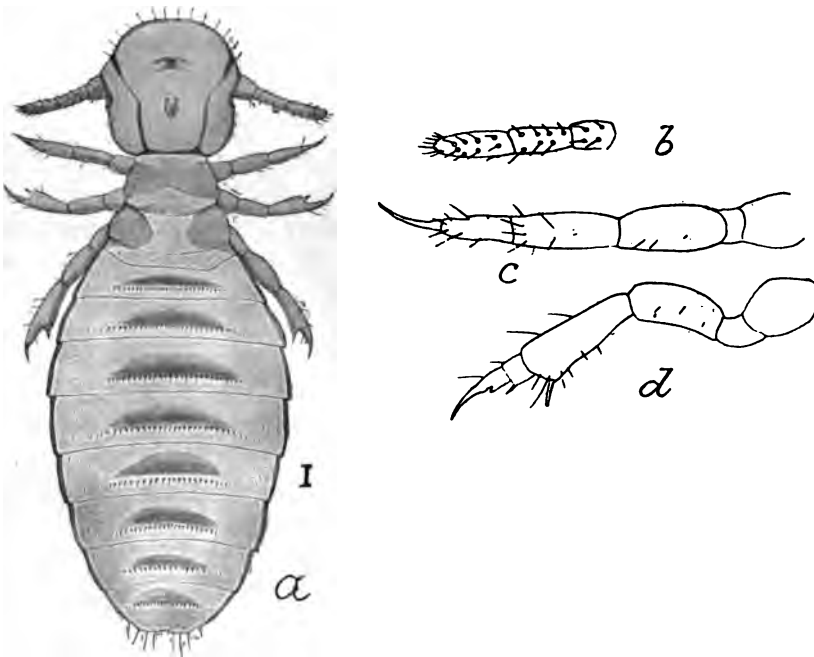


FIG. 3.—Sheep louse (*Trichodectes spharerocephalus*): a, female; b, antenna; c, d, dorsal and side view of leg. Enlarged. (After Osborn, 1896; Bul. No. 5, Div. Entomology, Dept. Agr.)

In this disease the parasites are much smaller than the psoropt of body scab. They are almost invisible to the naked eye, but may be seen with a magnifying glass. They are found on the moist under-surface of the crusts, and live on the fluids of the sheep. They give rise to a violent itching, causing the sheep to rub and scratch their heads and lick their lips; in advanced stages the eyes may be partly closed, and consequently the sight impaired; breathing and even eat-

ing may become difficult because of the formation of crusts around the mouth and nostrils. Small papules form, with soft centers; usually the rubbing causes them to break, and they exude a fluid which hardens and forms a scab; the scabs, increasing in number, may run together; they become thicker and harder, until almost the entire head is merged into one crust. Rubbing causes the crusts to break; the wounds heal and form scars; the skin thickens and is raised in folds, in which cracks appear and from which there may be bleeding. When affecting lambs the disease may assume an ulcerative character.

Parts of body affected.—This form of scab appears on parts of the body where the wool is scarce; usually beginning about the nostrils

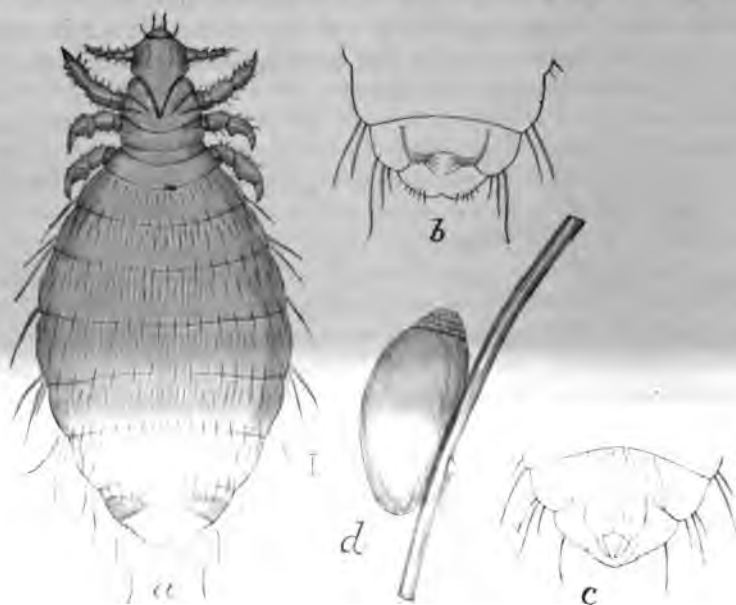


FIG. 4. Sheep foot louse (*Hematopinus pedalis*). *a*, adult female; *b*, ventral view of terminal segment of same, showing brushes; *c*, terminal segments of male; *d*, egg. Enlarged. (After Osborn, 1896, Bul. No. 5, Div. Entomology, Dept. Agr.)

and on the upper lip, more rarely about the eyes and ears, it spreads to the cheeks, eyes, forehead, and under the jaws; in severe cases it may extend to the belly, front legs, knees, hocks, and pasterns. Coarse dry wool favors it more than fine oily wool. The line between the diseased and the healthy skin is quite sharply defined.

Contagion.—Head scab is contagious from sheep to sheep, from sheep to goats, and rarely from sheep to man; when transmitted from sheep to horses, cattle, and dogs the disease remains local and does not spread. Head scab is also contagious from goats to sheep. Viborg states that the sarcoptic scab of pigs is contagious to sheep, but this is denied by Am-Pach. Chabert maintained that sarcoptic scab of dogs is transmissible to sheep, but this is doubtful.

Chances for recovery.—Head scab can be easily treated if taken in time, but if neglected it will cause inflammation of the eyes and extensive alterations in the skin, and will prevent the sheep from fattening.

(3) FOOT SCAB, OR CHORIOPTIC SCAB.

Foot scab is rare, if present at all, in this country, but a number of cases have recently been reported from England. It is not impossible that some of the cases supposed to be foot rot are in reality foot scab.

The minute parasites, which are much smaller than those of common scab, cause an intense itching, which leads the sheep to stamp their feet and scratch and bite the infected parts. There is a reddening of the skin, followed by scaling, and later by the formation of yellowish white crusts; the crusts thicken, cracks may form in the folds of the pasterns, and the legs may become quite unsightly.

Parts of the body affected.—The disease appears on the feet and legs, spreading slowly to the upper parts of the legs and the adjoining parts of the body, scrotum, or udder.

Contagion.—This disease is contagious from sheep to sheep, but not so actively as common scab.

(4) FOLLICULAR SCAB, OR DEMODECTIC SCAB.

The glands of a sheep's eyelids are occasionally infected with a fourth kind of microscopic mite, which is elongate and much like a worm. It has been recorded but a few times, and for the present, at least, is of no importance to the American sheep raiser.

CONDITIONS WHICH MAY BE MISTAKEN FOR SCAB.

Any parasite or condition which causes an itching, and thus leads the sheep to scratch themselves, or any abnormal condition of the skin, may be temporarily mistaken for scab; but if the rule is held in mind that no scab is possible without the presence of the specific parasites, it will be easily determined whether scab is present or not. The following are the more important cases to be considered:

(1) *Itching due to other parasites*, such as the common "sheep tick," true ticks, and lice, may be distinguished from scab by finding the parasites. The dipping used for treating scab will also kill sheep ticks and lice.

(2) *Inflammation of the sebaceous glands.*—This may be mistaken for common scab. It appears most frequently in autumn. There is a severe itching, the skin is red and sensitive, and is covered with a strong-smelling, yellowish, viscid yolk; tufts of wool may be shed. It may be cured, after shearing, with any starchy lotion.

(3) *Rain rot.*—In rainy weather an eruption may appear on the skin which might be mistaken for scab. There is, however, no parasite present; itching is absent, and the trouble disappears when dry weather comes.

THE TREATMENT OF SCAB.

In the foregoing discussion attention has been called to the necessity of keeping sheep under proper hygienic conditions. That alone, though of importance in connection with the subject of treatment, can not be relied upon to cure scab. The only rational treatment consists in using some external application which will kill the parasites. Formerly medicines were given internally, and even within a few years past it has been claimed that feeding sulphur to sheep will cure the disease. The statements regarding sulphur were such as to lead us to try the experiment, which, however, was soon abandoned as unsuccessful. The external application of scab cures is in various ways made known as hand dressing, hand curing, spotting, pouring, smearing, and dipping. Of these methods, dipping is by far the most satisfactory.

HAND APPLICATIONS.

In case of head scab, or in light cases of foot scab, hand applications may be resorted to, and will frequently suffice. A nonpoisonous ointment may be made by taking 4 ounces of oil of turpentine, 6 ounces of flowers of sulphur, and 1 pound of lard. Mix the ingredients at a gentle heat, and rub in well with the hands or with a brush, at the same time breaking the crusts. The simple sulphur ointment may be made of 1 part of sulphur and 4 parts of lard; one-fourth part of mercurial ointment may be added. Few remedies are so useful in mange in dogs, ringworm, and other itching complaints as sulphur iodide, and it may well be given a trial on head scab. It is prepared as follows: Mix in a nonmetallic vessel, as a porcelain mortar, 4 ounces of iodine with 1 ounce of sublimed sulphur, gently heating the mixture until it liquefies; the red-brown liquid upon cooling becomes a gray-black crystalline mass, insoluble in water, but soluble in glycerine and fats, with 8 or 10 parts of which it is mixed for ointments or liniments. An ointment of flowers of sulphur and carbolated vaseline would also probably give good results. One author advises for head scab and foot scab a mixture consisting of 1 part of mercurial ointment and 11 parts of sulphur ointment. Foot scab and head scab would also probably respond to treatment with the various dips used for common scab.

Hand dressing is not recommended for common scab; in fact, it must be looked upon as directly responsible for a considerable amount of the disease, since it is too often relied upon to cure the disease, while in reality it is only a palliative. The only condition under which hand dressings can be advised is in case scab is discovered in one or two sheep of a flock during severe winter weather, when dipping would be impracticable. In that event, the infected sheep should be immediately isolated from the flock; and they might be hand dressed, if desired, in order to hold the disease in check. It can not be too strongly insisted upon that "pouring," "spotting," etc., are only expensive and temporizing methods of dealing with scab.

"Pouring" is done as follows: Part the wool on the back by making a furrow with the finger from the head to the tail; furrows are also made along the shoulders and thighs to the legs, and on the sides; pour the ointment or dip in these furrows. A still better plan is to pour the warm dip from a coffeepot or teapot directly on the affected parts, rubbing it well in with the hand, a brush, or a corncob. It must be repeated for emphasis, however, that such treatment can not be relied upon, and should be used only in emergency cases when dipping is impracticable.

A mercurial ointment may be made as follows: (A) dissolve 1 pound of resin in one-half pint of oil of turpentine; (B) mix 1 pound of mercurial ointment with 6 pounds of lard, with gentle heat, and (C) when cool mix the two compounds, A and B. It should be remembered that mercurial ointments are not unattended with danger, and on this account it is better to prepare a small amount of dip and pour it on the affected part as described above.

DIPPING.

By far the most rational and satisfactory, and the cheapest method of curing scab is by dipping the sheep in some liquid which will kill the parasites. The dipping process is as follows:

(1) Select a dip containing sulphur. If a prepared "dip" is used which does not contain sulphur, it is always safer to add about 16½ pounds of sifted flowers of sulphur to every 100 gallons of water, especially if, after dipping, the sheep have to be returned to the old pastures.

(2) Shear all the sheep at one time, and immediately after shearing confine them to one-half the farm for two to four weeks. Many persons prefer to dip immediately after shearing.

(3) At the end of this time dip every sheep (and every goat also, if there are any on the farm).

(4) Ten days later dip the entire flock a second time.

(5) After the second dipping, place the flock on the portion of the farm from which they have been excluded during the previous four or five weeks.

(6) Use the dip at a temperature of 100° to 110° F.

(7) Keep each sheep in the dip for two minutes by the watch—do not guess at the time—and duck its head at least once.

(8) Be careful in dipping rams, as they are more likely to be overcome in the dip than are the ewes.

(9) Injury may, however, result to pregnant ewes, which must, on this account, be carefully handled. Some farmers arrange a stage, with sides, to hold the pregnant ewes, which is lowered carefully into the vat, and raised after the proper time.

(10) In case a patent or proprietary dip, especially an arsenical dip, is used, the directions given on the package should be carried out to the letter.

CHOICE OF A PREPARATION FOR DIPPING.

Numerous different sheep dips are recommended by various parties, and undoubtedly many of them are efficacious; few can be named which some persons do not consider far superior, and other persons consider far inferior to all other dips known; few can be found which have not cured cases of scab, and probably none can be named with which failures have not been reported. Under these circumstances the farmer should not be deceived by exaggerated statements in either extreme; he should recall that it lies in the business interest of the manufacturers of every proprietary or patent dip to advertise their own particular mixture in every way possible, but that too often these merchants pursue the method of deprecating the use of homemade dips as "dangerous," "ineffective," "liable to produce blood poisoning," etc., and of citing the accidents, failures, and dangers of other proprietary mixtures rather than of giving exact and reliable statements regarding the successes of their own compounds.

PROPRIETARY ARTICLES.

The Department can not properly advertise or recommend the use of any dip which is made from a secret formula. It can not be said that no such preparation has any value as a scab cure, or that such dips have never met with any success, for that would be a misrepresentation of facts. The farmer should, however, know the composition of the material he is using. If he desires to use a ready-made dip, let him inform himself of its exact nature in order to prevent impositions and guard against dangers. He would do well to refuse to purchase any prepared mixture which does not bear on each package a printed statement of the ingredients and their proportions, which the manufacturer guarantees are to be found in that package; he would also do well to avoid any compound which irresponsible parties advertise as "the only sure cure for scab," etc. Proprietors thus advertising are either showing gross ignorance of the history and nature of scab, and hence are not to be taken as advisers, or they are intentionally misrepresenting established facts.

In case of more than one proprietary article, it seems quite clear from the circulars and advertisements distributed by the manufacturers that the firms have had little or no practical experience with scab, and that the extravagant claims set forth by them for their mixtures are little less than artful methods of advertising, rather than statements based upon any tests or experiments. Good examples of worthless or almost worthless dips are cited by Bruce, who quotes the treatment of 80,021 cases of scab with *Allen's Specific*, with not a single case of cure! *Hayes's Specific* cured 6,255 cases and failed in 80,931 cases!

SUCCESS WITH HOMEMADE DIPS.

While a remedy should not be condemned simply because it is prepared ready for use—for it may be frankly admitted that there are some

excellent proprietary compounds—the value of homemade dips must be insisted upon, and attention is called to the fact that it was almost entirely through homemade mixtures that scab was eradicated from certain of the Australian colonies, and that year after year, in the reports of the scab inspectors of Capetown Colony, the first and third places are accorded to homemade dips, while second place is accorded (with some qualification) to a secret remedy. In this connection the following significant remarks, made in 1892 by the chief inspector of stock in Queensland, will be of interest:

Our Australian experience of tobacco and sulphur and of lime and sulphur as the only effectual means of curing scab is such that at the stock conference held in Sydney in 1886, and again in Melbourne in 1889, attended by the chief and Government veterinarians of all the colonies, it was on both occasions decided that none but these two dips be recognized in the colonies, and this has now been embodied in regulations under the "Stock disease acts" of all the colonies.

The stamping out of scab in these colonies has been more retarded by vendors of patent dips than by any other cause; hence the determination of the governments of all the colonies to forbid the use of any specific except tobacco and sulphur or lime and sulphur for scab or for the (precautionary) dressing of imported sheep while in quarantine.

In view of the more or less frequent statements that scab was eradicated from the English colonies by killing the scabby sheep or by the use of prepared dips it may be well to say that these statements are erroneous. "It is true an act was passed in New South Wales about 1851 compelling the slaughter of scabbed sheep, and a few remaining straggling flocks were destroyed under that act, but later, on the reappearance of scab in that colony in 1863 by infection from Victoria, the act was repealed, and the whole of the scabbed sheep, about 400,000, were completely cured by means of tobacco and sulphur."¹

IMPORTANCE OF PROPER USE OF DIP.

Whatever dip is selected, the farmer should not forget that there are two ways of using it. One way is to prepare and use it in accordance with the directions given; the other way is to attempt to economize time, labor, or money by using it in weaker proportion than advised, by hurrying the sheep through the swim, or by later placing the dipped sheep under unfavorable conditions. If the former method is adopted with any of the established dips, the treatment ought to be followed with favorable results; if the latter method is adopted, the farmer himself must assume the responsibility of failure, no matter what remedy he decides to use. Every farmer should therefore remember that when he has decided upon the dip he is to use his work has only begun; to use it properly is fully as important as to use a dip at all.

¹ Statement made by P. A. Gordon, chief inspector of stock, Queensland.

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¹ Statement made by P. A. Gordon, chief inspector of stock, Queensland.

PRELIMINARY QUESTIONS IN CHOOSING A DIP.

The homemade dips which are most commonly used have either tobacco or sulphur as their basis, while the prepared dips contain tobacco, sulphur, arsenic, carbolic acid, etc., as curative agents.

In selecting a dip several points should be considered: First of all, the question of expense will naturally arise; next, the question as to whether or not scab actually exists in the flock to be dipped, or whether or not the dipping is more of a precautionary matter, or for the sake of cleansing the animal's skin. The facilities at hand, the setback to the sheep, and the length of the wool are also matters for consideration, as well as the pastures into which the dipped sheep are to be placed. Notwithstanding statements to the effect that a given dip can be used under all conditions, the above questions are evidently important.

Expense.—In estimating the expense one should consider not only the actual outlay for the ingredients of the ooze, but the cost of fuel and labor, the injury, if any, to the sheep, and the liability of not curing the disease. It is much more economical to use an expensive dip and cure scab than it is to use a cheap dip and fail to cure it. To illustrate with a well-known homemade dip: A lime-and-sulphur dip may be made in ten to thirty minutes, with but little fuel and little labor, which may or may not cure the disease, and which will surely do great injury to the wool; or a lime-and-sulphur dip may be made in several hours' time, at the expense of considerable fuel, labor, and patience, which can be relied upon to cure scab, and which will do little or no injury to the wool. The first dip is cheap, but not economical; the second dip is more expensive, but more economical.

Does scab exist in the flock?—Every farmer should ask himself this question before he selects his dip. If scab does not actually exist and the wool is long, the dipping in this case simply being a matter of precaution, it is best not to select a dip containing lime. The use of the lime-and-sulphur dips is therefore not advised simply as precautionary dressing for healthy long-wooled sheep. On the contrary, the use of any dip containing lime, as a precautionary measure, should be avoided.

The facilities at hand for preparing dip.—If fuel is very scarce, so that it is impracticable to boil the mixture for at least two hours, the lime-and-sulphur dips should not be selected. A tobacco-and-sulphur dip, as well as many of the better proprietary dips, can be made without the necessity of lengthy boiling, and should be given preference whenever facilities for boiling are not at hand.

The length of the wool.—See remarks upon this subject in discussion of lime and sulphur, page 26.

The pastures.—In case it is necessary to place the dipped sheep on the same pastures they occupied before being dipped, it is always best to use a dip containing sulphur. If a proprietary dip is selected under those circumstances, it is suggested that sulphur be added, about 1 pound of flowers of sulphur to every 6 gallons of dip. In case it is

possible to utilize fresh pastures after dipping, the use of sulphur is not so necessary, but is always advisable. The object in using sulphur is to place in the wool a material which will not evaporate quickly, but will remain there for a longer period of time than the scab parasites ordinarily remain alive away from their hosts. By doing this the sheep are protected against reinfection.

KINDS OF DIPS.

Sulphur is one of the oldest known remedies for scab, its use dating back to Columella in the early part of the Christian era. As a scab eradicator, it must be placed among the best substances at our disposal. It is one of the constituents of certain proprietary dips, but its use to the farmer is best known in the tobacco-and-sulphur dip and in the lime-and-sulphur dip. These homemade mixtures are the two dips which have played the most important rôles in the eradication of scab from certain English colonies, and their use, especially the use *as well as the abuse* of lime and sulphur, is quite extensive in this country.

THE TOBACCO-AND-SULPHUR DIP.

The formula, as given here and as adopted by the New South Wales sanitary authorities, appears to have first been proposed in 1854 by Mr. John Rutherford. Regarding its success in Australia, Dr. Bruce, chief inspector of sheep for New South Wales, makes the following statements:

On the Hopkins Hill Station Mr. Rutherford, with two dressings of these ingredients, then cured over 52,000 sheep which had been infected for eighteen months; and he also subsequently cured with two dippings the sheep on Mount Fyans Station, where they were in a most wretched state, and had been scabby for more than three years, and that, too, in both cases, without destroying a single hurdle or yard or removing any of the sheep from their old runs.

Since then millions of scabby sheep have been permanently cured in Victoria in the same way, and in South Australia and New South Wales hundreds of thousands of scabby sheep have also been cleansed with tobacco and sulphur. In fact, this dressing has the credit of having eradicated scab from the flocks of both the latter colonies, and there are good grounds for asserting that had this remedy not been known and used neither colony would be, as they both are now, almost entirely free from the scourge. Judging therefore from the experience of the three colonies, there is no medicament or specific yet known [1884] that can be compared with tobacco and sulphur as a thorough and lasting cure for scab in sheep.

The proportions adopted by Rutherford, and afterwards made official by the scab sanitary authorities, are:

Tobacco leaves.....	pound..	1
Flowers of sulphur	do.....	1
Water	gallons..	¹ 6

The advantage of this dip lies in the fact that two of the best scab remedies, namely, tobacco (nicotine) and sulphur, are used together,

¹The original formula reads 5 gallons (imperial) which are equivalent to 6 United States gallons.

both of which kill the parasites, while the sulphur remains in the water and protects for sometime against reinfection. As no caustic is used to soften the scab, heat must be relied on to penetrate the crusts.

Directions for preparing the dip.—A. Infusing the tobacco: Place one pound of good leaf or manufactured tobacco for every 6 gallons of water desired in a covered boiler of cold or lukewarm water and allow to stand for about twenty-four hours; on the evening before dipping bring the water to near the boiling point (212° F.) for an instant, then remove the fire and allow the infusion to stand over night.

B. Thoroughly mix the sulphur (1 pound to every 6 gallons of water desired) with the hand in a bucket of water to the consistency of gruel.

C. When ready to dip, thoroughly strain the tobacco infusion from the leaves by pressure, mix the liquid with the sulphur gruel and add enough water to make the required amount of dip and thoroughly stir the entire mixture.

All things considered, the tobacco-and-sulphur is as good a dip as is known at the present time.

See also the discussion of the tobacco dip on page 30.

LIME-AND-SULPHUR DIPS.

Under the term "lime-and-sulphur dips" is included a large number of different formulæ requiring lime and sulphur in different proportions. In general practice all of these dips are spoken of as "the lime-and-sulphur dip," but in reality each separate formula represents a separate dip.

To give an idea of the variety of the lime-and-sulphur dips, the following list is quoted, the ingredients being reduced in all cases to avoirdupois pounds and United States gallons:

1. The original "Victorian lime-and-sulphur dip" proposed by J. H. Rowe, adopted as official in Australia:

Flowers of sulphur	pounds..	20
Fresh slaked lime	do.....	10½
Water	gallons..	100

2. South African (Cape Town) official lime-and-sulphur dip:

Flowers of sulphur (minimum)	pounds..	15
Unslaked lime	do.....	15
Water	gallons..	100

3. South African (Cape Town) official lime-and-sulphur dip, February 1, 1897:

Flowers of sulphur	pounds..	20
Unslaked lime	do.....	16½
Water	gallons..	100

4. Nevada lime-and-sulphur dip:

Flowers of sulphur	pounds..	16½
Lime	do.....	33½
Water	gallons..	100

5. Fort Collins lime-and-sulphur dip:

Flowers of sulphur	pounds..	33
Unslaked lime.....	do....	11
Water	gallons..	100

6. A mixture which, used to some extent by this Bureau, contains the same proportions of lime and sulphur (namely, 1 to 3) as the Fort Collins dip, but the quantities are reduced to:

Flowers of sulphur	pounds..	24
Unslaked lime.....	do....	8
Water	gallons..	100

Dangerous formulæ.

7. California lime-and-sulphur dip:

Flowers of sulphur	pounds..	100
Lime.....	do....	25
Water	gallons..	100

8. A very dangerous misprinted formula to be found in several books and journals, probably due to a typographical error:

Flowers of sulphur	pounds..	100
Lime.....	do....	150
Water	gallons..	100

In case of fresh scab formula No. 6 will act as efficaciously as the dips with a greater amount of lime, but in cases of very hard scab a stronger dip, as the Fort Collins dip, should be preferred, or, in unusually severe cases, an ooze with more lime in proportion to the amount of sulphur, such as the Victorian (No. 1), the Nevada (No. 4), or the South African (No. 3) dip might be used.

Many other formulæ might be cited, but these are enough to show the great variations in the dips which have been used; and to prove that when a party simply states that "lime and sulphur" is an excellent dip, or that it is a dangerous dip, or that he has succeeded or failed with it, or that the lime-and-sulphur dip is injurious to the wool, his statements can not be taken as definite, unless he also states which lime-and-sulphur dip he used and how he used it.

Prejudice against lime-and-sulphur dips.

There is at present great prejudice (a certain amount of it justified no doubt) against the use of lime and sulphur, emanating chiefly from the agents of patent or proprietary dips and from the wool manufacturers. It will be well therefore to consider the points brought forward by them against its use.

In the first place, it is frequently asserted that lime and sulphur does not cure scab. This statement is, of course, in the interest of proprietary dips, but it is based either upon an absolute ignorance or a misrepresentation of facts. Experience in Australia and South Africa, as well as in this country, has shown beyond any doubt that a lime-and-sulphur dip, when properly proportioned, properly prepared, and properly used, is one of the best scab eradicators known. Cases of its

failure have been due to careless or improper methods of its preparation and use.

It is claimed by some that it produces "blood-poisoning." But the cases of death following the use of lime-and-sulphur dips have been infinitesimally few when compared with the number of sheep dipped in these solutions and when compared with the deaths which have been known to follow the use of certain proprietary dips. The details of such accidents so far as they have been reported have not shown that death was due to any properly prepared and properly used lime-and-sulphur dip. If the formula of 100 pounds of sulphur, 150 pounds of lime, and 100 gallons of water has killed animals, that surely is no argument against the formula 33 pounds of sulphur, 11 pounds of lime, and 100 gallons of water, but simply shows that the former formula is too strong; if any other conclusion than this is drawn, consistency would compel us to reject many of our most valuable remedies because some parties had used them in overdose. The argument frequently raised against lime and sulphur—namely, that "shear-cut" sheep die when dipped immediately after shearing in a lime-and-sulphur dip which has stood for some time—can be used equally well against other dips, and simply shows that it is safer to use a fresh supply of dip and to allow a short time to elapse after shearing before dipping. It is highly probable that the cases of so-called "blood-poisoning" of shear-cut sheep are generally due to an infection with bacteria in stale dip containing putrefying material. Some cases of death are also said to have occurred after using a lime-and-sulphur dip made in brass kettles.

In an experiment by this Bureau, 5 cc. of a clear lime-and-sulphur ooze (Formula No. 6) has been injected under the skin of a sheep without producing any evil effects.

The greatest objection raised against the use of lime-and-sulphur dip is that it injures the wool. This objection is raised by many wool manufacturers, and echoed with ever-increasing emphasis by the manufacturers of prepared dips; while, after years of extensive experience with properly prepared dip, its injury to the wool is strongly and steadfastly denied by the agricultural department of Cape Colony.

It is believed that a certain amount of justice is attached to this objection to lime and sulphur as generally used; unless, therefore, lime and sulphur can be used in a way which will not injure the wool to an appreciable extent, we should advise against its use in certain cases; in certain other cases the good accomplished far outweighs the injury it does. Let us, therefore, examine into this damage and its causes.

The usual time for dipping sheep is shortly after shearing, when the wool is very short; whatever the damage at this time, then, it can be only slight, and the small amount of lime left in the wool will surely do but little harm.

In full fleece, lime and sulphur will cause more injury. In Australia the deterioration was computed by wool buyers at 17 per cent, although in Cape Colony the department of agriculture maintains that if prop-

erly prepared, and if only the clear liquid is used, the sediment being thrown away, the official lime-and-sulphur formula will not injure the long wool. In our own experiments we have found some samples of wool injured by dipping, while on other samples no appreciable effect was noticeable.

It must not be forgotten that other conditions, such as variations in the feed, pasturing on alkaline land, ill health from any cause, etc., may cause brittleness of the wool, which might be mistaken for the effects of lime and sulphur.

If a lime-and-sulphur dip is used, care must be taken to give the solution ample time to settle, then only the clear liquid should be used, while the sediment should be discarded. In some of our tests on samples of wool we have found that the dip with sediment has produced very serious effects even when no appreciable effects were noticed on samples dipped in the corresponding clear liquid.

Experience has amply demonstrated that a properly made and properly used lime-and-sulphur dip is one of the cheapest and most efficient scab eradicators known, but its use should be confined to flocks in which scab is known to exist, and to shorn sheep, with the exception of very severe cases of scab in unshorn sheep. It should only be used when it can be properly boiled and settled. The use of lime-and-sulphur dips in flocks not known to have scab, especially if the sheep are full fleeced, can not be recommended; in such cases tobacco, or sulphur and tobacco, is safer and equally good.

If a lime-and-sulphur dip is chosen, it is better for ordinary cases to use the solutions containing a small amount of lime and three times as much sulphur as lime, as the Fort Collins formula (33 pounds of sulphur and 11 pounds of lime to every 100 gallons of water) or the Bureau of Animal Industry formula (No. 6) (24 pounds of sulphur and 8 pounds of lime to 100 gallons of water), rather than the formula with a greater proportion of lime.

If the stronger solutions, as the Victorian formula (No. 1), or the present South African formula (No. 3), or the Nevada formula (No. 4) are used at all, their use should be confined to unusually severe outbreaks. Under no circumstances should the Californian formula (No. 7) or formula No. 8 be used. They are too strong, and the latter is especially liable to kill the sheep.

Another objection raised to the use of lime and sulphur is the claim that the "shrinkage" in the sheep after the use of these dips is greater than after the use of other dips. In reply to this objection, raised chiefly by patent-dip manufacturers, it can only be repeated that such has not been the experience of this Bureau (see p. 35), nor was it the experience of Professor Gillette in his experiments in Colorado. The burden of proof for the opposite statement, with exact statistics, rests upon those who raise this objection.

Still another objection advanced against lime and sulphur is that its continued use year after year will gradually decrease the annual

clip. Whether this objection be valid or not, it is scarcely necessary to discuss it in detail in this place; for, in the first place, the average sheep raiser of this country does not keep the same sheep "year after year," but sends most of his sheep (breeding ewes and the rams excepted) to market. Hence there will usually be little opportunity to injure the wool of a given animal "year after year." In the next place, if lime and sulphur are properly used one year, so that the flock is freed from scab and if reinfection be guarded against, it will not be necessary to resort again to lime and sulphur.

These objections have been reviewed somewhat in detail in order to place the facts, so far as obtainable, before the farmer. It is not particularly advised by the Bureau that lime and sulphur be used in this country in preference to sulphur and tobacco, or tobacco alone, or any other effective dip. In fact, it is hoped that within ten years there will be no further use for the lime-and-sulphur dips. At the same time, where it is a choice, on the one hand, between lime and sulphur, with a temporary slight deterioration in the value of wool, but an absence of scab, and, on the other hand, the use of a secret and ineffective patent dip, with the continual presence of scab, and hence permanent deterioration in wool, there can be no doubt that the decision should be in favor of lime and sulphur (properly prepared and properly used).

All things considered, where it is a choice between sacrificing the weight of sheep, and to some extent the color of the wool, by using tobacco and sulphur, and sacrificing the staple of the wool by using lime and sulphur, the farmer should not hesitate an instant in selecting tobacco in preference to lime. The loss in weight by using tobacco and sulphur is not much greater than the loss in using lime and sulphur, while the loss in staple is of more importance than a slight discoloration.

Preparation of the mixture.—Almost as many different methods of preparing the liquid exist as there are different formulæ, some of the methods laying great stress upon sifting both the lime and the sulphur, others laying great stress upon allowing the liquid to settle, others leaving out of consideration both of these points. The method which has been found in the Bureau to be the easiest and most satisfactory is as follows:

A. Take 8 to 11 pounds of unslaked lime, place it in a mortar box or a kettle or pail of some kind, and add enough water to slake the lime and form a "lime paste" or "lime putty."¹

B. Sift into this lime paste three times as many pounds of flowers of sulphur as used of lime, and stir the mixture well.

¹ Many persons prefer to slake the lime to a powder, which is to be sifted and mixed with sifted sulphur. One pint of water will slake three pounds of lime if the slaking is performed slowly and carefully. As a rule, however, it is necessary to use more water. This method takes more time and requires more work than the one given above, and does not give any better results. If the boiled solution is allowed to settle the ooze will be equally as safe.

Be sure to weigh both the lime and the sulphur. Do not trust to measuring them in a bucket or to guessing at the weight.

C. Place the sulphur-lime paste in a kettle or boiler with about 25 to 30 gallons of boiling water, and boil the mixture for two hours at least, stirring the liquid and sediment. The boiling should be continued until the sulphur disappears, or almost disappears, from the surface; the solution is then of a chocolate or liver color. The longer the solution boils the more the sulphur is dissolved, and the less caustic the ooze becomes. Most writers advise boiling from thirty to forty minutes, but we obtain a much better ooze by boiling from two to three hours, adding water when necessary.

D. Pour the mixture and sediment into a tub or barrel placed near the dipping vat and provided with a bung-hole about four inches from the bottom and allow ample time (two to three hours, or more if necessary) to settle.

The use of some sort of settling tank provided with a bung-hole is an absolute necessity, unless the boiler is so arranged that it may be used both for boiling and settling. An ordinary kerosene oil barrel will answer very well as a small settling tank. To insert a spigot about three to four inches from the bottom is an easy matter. Draining off the liquid through a spigot has the great advantage over dipping it out in that less commotion occurs in the liquid, which therefore remains freer from sediment.

E. When fully settled, draw off the clear liquid into the dipping vat and add enough warm water to make 100 gallons. The sediment in the barrel may then be mixed with water and used as a disinfectant, *but under no circumstances should it be used for dipping purposes.*

A double precaution against allowing the sediment to enter the vat is to strain the liquid through ordinary bagging as it is drawn from the barrel.

In watching the preparation of lime-and-sulphur dips by other parties the Bureau investigators have found some persons who laid great stress upon stirring the sediment well with the liquid before using the ooze. This custom is undoubtedly responsible for a great deal of the prejudice which exists at present against lime-and sulphur dips; and considering the preparation of these dips in this way there is no wonder at the immense prejudice against them in certain quarters.

To summarize the position of the Department on the lime-and-sulphur dips: When properly made and properly used, these dips are second to none and equaled by few as scab eradicators. There is always some injury to the wool resulting from the use of these dips, but when properly made and properly used upon shorn sheep it is believed that this injury is so slight that it need not be considered; on long wool the injury is greater and seems to vary with different wools, being greater on a fine than on a coarse wool. This injury consists chiefly in a change in the microscopic structure of the fiber, caused by the caustic action of the ooze. When improperly made and improperly used the lime-and-sulphur dips are both injurious and dangerous, and

in these cases the cheapness of the ingredients does not justify the use. In case scab exists in a flock and the farmer wishes to eradicate it, he can not choose a dip which will bring about a more thorough cure than will lime and sulphur (properly made and properly used), although it will be perfectly possible for the farmer to find several other dips which will, when properly used, be nearly or equally as effectual as a lime-and-sulphur dip. There is no dip to which objections can not be raised.

POTASSIUM SULPHIDE DIP.

It has been proposed by several parties to use a potassium sulphide dip, and such a dip has been tried to some extent. As yet, however, judgment upon it must be reserved. Gillette tried a dip composed of 4½ pounds of potash lye, 16 pounds of flowers of sulphur, and 100 gallons of water, and promises further reports on its effectiveness. Sheep dipped in this liquid gained but 6 pounds, namely, the same as sheep treated with carbolic dip.

TOBACCO DIPS.

The active principle of tobacco, upon which the tobacco dips depend for their action, is a poisonous substance known as nicotine. This is a poison when applied to animals externally in too strong solutions may cause nausea, fainting, and even death. The dog and the rabbit are particularly susceptible to its effects. Diluted to about thirty-three one-thousandths to sixty one-thousandths of 1 per cent it makes a safe but sure-acting and excellent sheep dip.

Unfortunately the percentage of nicotine varies greatly, not only in different kinds of tobacco, but also in different parts of the plant, in different years, and even in different parts of the same package. There is more nicotine in the leaves, for instance, than in the stems. In fermented tobacco there seems to be a certain relation between the amount of nicotine and the amount of juice present, so that in general dry, thin leaves do not contain so much nicotine as thick, "fat" leaves. The variation in percentage of nicotine in different kinds of tobacco may be seen from the following table of determinations taken from Kissling, 1893:

Statement giving the name of tobacco and amount of nicotine in percentage of dry substance.

Percent.		Percent.	
Virginia	4.80	Brazil	1.
Virginia	1.30	Turkish	2.
Kentucky	1.50	Elissee	1.
Sumatra	1.10	Elissee	0.
Seedleaf	3.70	Maryland	1.
Seedleaf	3.00	Maryland scrubs	1.
Havana	3.00	Carman	1.
Havana	1.90	Ohio Bay	1.
Brazil	2.78	Ambalra	1.
Brazil Felix	2.73	Domingo	0.
Brazil Felix	1.25	Ohio	0.
Java	2.61		

In four carloads of stems, aggregating 127,273 pounds, one American firm extracted 1,405.43 pounds of nicotine, or 1.104 per cent.

While the above figures represent the percentages extracted in the chemical and manufacturing laboratories, they do not necessarily represent the amount which the farmer would be able to extract with the methods and apparatus at his disposal. On account of the variation in the amount of nicotine in the different samples of tobacco, it is practically impossible for the farmer to make up an exact desired strength of tobacco dip if he prepares his own mixture from the leaves. He can, however, prepare a mixture which will come within the limits necessary to kill the scab parasites. If a solution of an exact given strength is desired, it will be necessary to buy prepared nicotine, or prepared tobacco dips of a guaranteed strength and reduce them to the strength determined upon.

To prepare the tobacco dip from the leaves, it is best to use at least 21 pounds of leaves to every 100 gallons of water. Assuming that a tobacco leaf is used from which the farmer might extract 2 per cent of nicotine, the 100 gallons of ooze would contain slightly more than five hundredths of 1 per cent; to obtain 100 gallons of ooze of thirty-three one-thousandths of 1 per cent strength, it would be necessary to use 21 pounds of tobacco yielding nearly 1.3 per cent nicotine.

Directions for preparing the dip.—For every 100 gallons of dip desired, take 21 pounds of good prepared tobacco leaves; soak the leaves in cold or lukewarm water for twenty-four hours in a covered pot or kettle; then bring the water to near the boiling point for a moment and, if in the morning, allow the infusion to draw for an hour; if in the evening, allow it to draw over night; the liquid is next strained (pressure being used to extract as much nicotine as possible from the wet leaves) and diluted to 100 gallons per 21 pounds of tobacco. This dip should be used as fresh as possible as it contains a large amount of organic material which will soon decompose.

The proportions here given, 21 pounds of prepared tobacco leaves to 100 gallons of water, have given very satisfactory results, especially in Cape Town colony, where the reports of the scab inspectors accord this homemade tobacco dip third place among the dips officially recognized. In regard to one of the proprietary tobacco dips the Cape Town agricultural department reports as follows: "Highly spoken of by several inspectors. Very efficacious, and improves the quality of the wool, making it soft and pliable. The one thing which militates against its general use is its expense, hindering the poorer farmers from using it. It is allowed to be one, if not the best, of the patent dips in use, and also the safest." By all means the use of a tobacco dip, or of the tobacco-and-sulphur dip, in preference to the lime-and-sulphur dips is advised in case the sheep to be dipped show no unmistakable signs of scab.

The advantages of the tobacco dip are that it is comparatively cheap,

since the farmer can grow his own tobacco; that it is effectual and at the same time not injurious to the wool. The disadvantages of the dip are that it sometimes sickens the sheep; that it also occasionally sickens the persons who use it, especially if they are not smokers; it spoils very rapidly; it causes a greater setback than lime and sulphur, but less of a setback than carbolic dips.

ARSENICAL DIPS.

There are both homemade arsenical dips and secret proprietary arsenical dips. It is well to use special precautions with both because of the danger connected with them. One of the prominent manufacturers of dips, a firm which places on the market both a powder arsenical dip and a liquid nonpoisonous dip, recently summarized the evils of arsenical dips in the following remarkable manner:

The drawbacks to the use of arsenic may be summed up somewhat as follows: (a) Its danger as a deadly poison. (b) Its drying effect on the wool. (c) Its weakening of the fiber of the wool in one particular part near the skin, where it comes in contact with the tender wool roots at the time of dipping. (d) Its not feeding the wool or stimulating the growth, or increasing the weight of the fleece, as good oleaginous dips do. (e) The danger arising from the sheep pasturing, after coming out of the bath, where the wash may possibly have dripped from the fleece, or where showers of rain, after the dipping, have washed the dip out of the fleece upon the pasture. (f) Its occasionally throwing sheep off their feed for a few days after dipping, and so prejudicing the condition of the sheep. (g) Its frequent effect upon the skin of the sheep, causing excoriation, blistering, and hardness, which stiffen and injure the animal, sometimes resulting in death.

Although this manufacturer has gone further in his attack upon arsenic than this Bureau would have been inclined to do, it must be remarked that when a manufacturer of such a dip can not speak more highly of the chief ingredient of his compound than this one has done in the above quotation, his remarks tend to discredit dips based upon that ingredient. It might be added that Bruce, the chief inspector of live stock for New South Wales, pays his respects to arsenical dips with the statement, "Arsenic and arsenic and tobacco (with fresh runs) cured 9,284 and failed with 9,271."

It may be said, on the other hand, that arsenic really has excellent scab-curing qualities; it enters into the composition of a number of the secret dipping powders and forms the chief ingredient in one of the oldest secret dips used. This particular dip has been given second place (with some qualifications) among the officially recognized dips in South Africa. In deference to the opinion of those who prefer an arsenical dip several formulæ are quoted here.

Formula for arsenical dips.—Finlay Dun recommends the following: Take 3 pounds each of arsenic, soda ash (impure sodium carbonate) or pearl ash (impure potassium carbonate), soft soap, and sulphur. A pint or two of naphtha may be added if desired. The ingredients are best dissolved in 10 to 20 gallons of boiling water and cold water is

added to make up ¹ 120 gallons. The head of the sheep must, of course, be kept out of the bath.

A mixture highly indorsed by certain parties consists of the following ingredients:

Commercially pure arsenite of soda	pounds..	14
Ground roll sulphur	do....	34 $\frac{1}{2}$
Water	gallons (U. S.)..	432

The arsenite of soda is thoroughly mixed with the sulphur before being added to the water.

Precautions in use of arsenical mixtures.—Any person using an arsenical dip should bear in mind that he is dealing with a deadly poison. The following precautions should be observed:

(1) Yards into which newly dipped sheep are to be turned should first be cleared of all green food, hay, and even fresh litter; if perfectly empty they are still safer. (2) When the dipping is finished, the yard should be cleaned, washed, and swept, and any unused ooze should at once be poured down a drain which will not contaminate food or premises used by any animals. (3) Dipped sheep should remain in an open, exposed place, as on dry ground. (4) Overcrowding should be avoided, and every facility given for rapid drying, which is greatly facilitated by selecting fine, clear, dry weather for dipping. (5) On no account should sheep be returned to their grazings until they are dry and all risk of dripping is passed.

Suggestion as to danger.—The formulæ given above are copied from the writings of men who have had wide experience in dipping, but this Bureau assumes no responsibility for the efficacy of the dips given or for their correct proportions. Furthermore, as long as efficacious non-poisonous dips are to be had, we see no necessity for running the risks attendant upon the use of poisonous dips.

CARBOLIC DIPS.

A carbolic-acid dip may be made at home or may be purchased as a proprietary article. This class of dips kills the scab mites very quickly, but unfortunately the wash soon leaves the sheep, which is consequently not protected from reinfection in the pastures. If, therefore, a carbolic dip is selected, it is well to add flowers of sulphur (1 pound to every 6 gallons) as a protection against reinfection.

The advantages of carbolic dips are that they act more rapidly than the tobacco or sulphur dips, and that the prepared carbolic dips are very easily mixed in the bath. They also seem, according to Gillette, to have a greater effect on the eggs of the parasites than either the sulphur or the tobacco dips. The great disadvantages of this class of dips are, first in some of the proprietary dips, that the farmer is uncertain regarding the strength of material he is using; second, the sheep

¹ The original formula reads 100 (imperial) gallons, which equal 120 United States gallons.

receive a greater setback than they do with either lime and sulphur or tobacco.

Gillette reports most excellent results from the use of a certain proprietary carbolic dip. The Bureau purchased the same dip upon the open market and tested its effects upon the sheep in the proper manner recommended by the manufacturer on the label of the package, also in one-half and one-third that strength. In the first and second tests the dip was severe both on the sheep and on the operators. In one case it caused a considerable, though temporary, eruption on the hands and arms of an operator. In all three cases the dipped sheep were almost overcome in the dipping tank, and upon recovering themselves ran around the field in an excited manner, bleating loudly and shaking their heads and tails. The eyes were more congested than we have ever seen them to be after a lime-and-sulphur or a tobacco dip.

An objection to some of the proprietary carbolic dips is that the manufacturers themselves apparently are little acquainted with their own mixtures. Their claims are extravagant and their directions are contradictory. It may be admitted that the carbolic dips are promising and that they may have a brilliant future, but they have not had a very brilliant past, and this Bureau is inclined to be extremely conservative in regard to them and to advise their manufacturers to prepare them in a guaranteed strength with more explicit directions for use than are to be found in the present circulars. The dip just referred to was certainly more severe in its effects on the sheep than can be justified by its quick action in killing the scab parasites, considering that other equally effective but milder solutions are to be had.

We also found in our tests (which are not yet fully completed) that the sheep have gained less in weight when dipped in certain two of these washes than when dipped in lime and sulphur, or in sulphur and tobacco, or in tobacco.

If a carbolic dip is used care must be taken that the ingredients form a thorough emulsion; if a scum arises to the top, a softer wash should be used.

In justice to this class of dips it is only fair to state that while the views here expressed are entirely in accord with the opinions of some authorities, they do not agree with the views held by others; but they are based upon the material purchased in open market, and probably represent the experience of many who have used these dips. The investigations of the Bureau certainly show that more tests are necessary before this class of dips can be indorsed. It is hoped that the necessary tests may be made in the near future.

One of the prominent proprietary carbolic dips was formerly recognized as one of the three official dips in New South Wales, but it has now been stricken from the list. In Cape Town carbolic dips are not much used, and in the official reports little is said concerning them.

SETBACK TO THE SHEEP FROM DIPPING.

Dipping often results in a slight setback. If sheep are weighed immediately before dipping, and again at the same hour the following day, it will be noticed that the weight has changed. There may be a gain, but usually there is a loss varying from $\frac{1}{2}$ to $3\frac{1}{2}$ pounds. The second day there may also be either a gain or loss. As the weight of sheep varies from day to day, from 1 to 5 pounds in loss or gain, due chiefly to the increase or decrease of the amount of fodder and water in the stomach, the effects of dipping can not be estimated in twenty-four or forty-eight hours. In order to meet statements made concerning loss or gain in weight, this Bureau had sheep dipped at stated intervals, and the weights taken from week to week; all the sheep were kept under exactly the same conditions; the dips used were lime and sulphur, tobacco and sulphur, and two proprietary carbolic dips.

At the end of about two months, after three dippings, all of the sheep showed a gain, with the exception of one of the sheep from the carbolic dip, which lost slightly. The lowest gain among the sheep treated with tobacco dip was $3\frac{1}{2}$ pounds, the highest $11\frac{1}{2}$ pounds. The lowest gain among the sheep treated with lime and sulphur was 7 pounds, the highest $8\frac{1}{2}$ pounds. The lowest gain among the sheep treated with the carbolic dip was $1\frac{1}{2}$ pounds, the highest $3\frac{1}{2}$ pounds, while one animal lost $\frac{1}{2}$ pound. The sheep were given a fourth dipping, and at the end of another month showed the following gains and losses over their original weight at first dipping: Sheep treated with tobacco, 9 to 15 pounds gain; sheep treated with lime and sulphur, $11\frac{1}{2}$ to 14 pounds gain; sheep treated with carbolic dip, 1 to $6\frac{1}{2}$ pounds gain, in one case $13\frac{1}{2}$ pounds lost.

The experiment was then repeated, the lime and sulphur being used on sheep previously dipped in carbolic or tobacco dips, and vice versa. After ten days the sheep treated with lime and sulphur had gained from 2 to 3 pounds; the sheep treated with tobacco had remained stationary or had lost from 1 to $1\frac{1}{2}$ pounds; the sheep treated with carbolic dip had gained as high as 1 pound, or remained stationary, or had lost as much as $2\frac{1}{2}$ pounds. At this point circumstances intervened which closed the experiments for the season.

Gillette has also made determinations of the loss of weight of sheep from dipping. Part of his results agree with ours and part differ. The chief point of difference in opinion is that Gillette considers that the best conclusion can be based upon weights taken a few days after dipping, while we consider the weight at a later period as the better criterion. Gillette gives weights from November 17 to December 22, and, taking the cases where the sheep have been dipped twice, we see from his tables that the carbolic sheep gained on an average 6 pounds, the sheep treated with tobacco gained 8 pounds, the sheep treated with arsenical dip gained 8 pounds, the sheep treated with lime and

sulphur¹ gained 9 pounds, while the sheep which were not dipped, in order to give a basis for comparison, gained 6 pounds.

Holding in mind that sheep may apparently gain or lose about 3 pounds per day when not dipped, it is seen from the experiments by Gillette, in Colorado, and by this Bureau, in the District of Columbia, that the oft-repeated claim that lime-and-sulphur dips give a greater setback than other dips is erroneous. In both the Western and the Eastern experiments the sheep treated with lime and sulphur averaged the greatest gain, the sheep treated with tobacco the second highest gain, while the carbolic sheep showed the lowest gain.

DIPPING PLANTS.

There are numerous kinds of dipping plants in use, the size and style varying according to the conditions which are to be met and the individual taste of the owner.

The farmer who has but a small flock can use a small portable vat for dipping, turning a part of his barn or some shed into a catching pen; by holding the sheep a moment at the top of the incline, as the animals emerge from the vat, and allowing them to drain, he can do away with the necessity of a draining yard.



FIG. 5.—A simple caldron which may be used for boiling dip.

When large flocks are to be dipped at stated periods it will be economy to build a more permanent plant. Such a plant should consist of (1) collecting and forcing yards, provided with a (2) drive and (3) chute, or slide, into the (4) dipping vat, from which an (5) incline with cross cleats leads to the (6) draining yards.

Heating tanks or boilers are also necessary. For a small vat any portable caldron (figs. 5 and 6) with a capacity of 30 to 100 gallons will answer, and the proper temperature may be maintained by pouring fresh hot ooze into the vat as the supply is exhausted by the dipping. In the large permanent plants the temperature can best be regulated by means of a steam pipe or hot water coil close to the floor of the tub.

Thermometers are an absolute necessity. The floating dairy thermometer (fig. 7) will be found to be most convenient, and several extra thermometers should be kept on hand to replace broken instruments. The thermometer is dropped into the vat and allowed to float for a short time, then quickly removed and the temperature determined. It is well to make paint marks at the side of the 100° and 110° points.

¹Unfortunately for the comparison this lot did not receive the same fodder as the others.

Building material.—The yards and vat may be built of wood, concrete, cemented stone, or brick, according to the individual taste of the owner and the facilities at hand.

Dimensions.—The dimensions of the various parts given in the following descriptions may be varied according to the breed and the number of sheep to be dipped. Dipping liquid will be saved by making the tub much narrower on the bottom than at the top. On top, simple oblong dipping tanks vary from 1 foot 9 inches to 3 feet in breadth, 2 feet or 2 feet 6 inches forming a convenient medium. Floors vary from 6 inches to 3 feet in width, 9 inches forming a good working medium. Depth varies from 3 feet to 5 feet 6 inches, 4 feet to 5 feet forming a



FIG. 6.—A caldron with stove.

convenient medium. If calves are to be dipped in the same vat it will be best to make the tub 5 feet or 5 feet 6 inches deep.

In sinking the tub in the ground it is always well to have the top of the tub 9 inches above the ground line. It is also well to sink one end (where the sheep are thrown in) slightly lower than the other end, as this will make it easier to empty and clean the vat.

Crutches, or forks.—In using large vats crutches, or dipping forks, are necessary, and even with small vats they are useful. Crutches should be 5 or 6 feet long. The handle should be strong (rake handles are a little too light). One end is provided with an iron ferrule, into which the bent iron is inserted. The iron should be one-half inch round

or three-quarters inch half round. The form of the crutches is shown in figs. 8 and 9.

Gauges.—The capacity of tubs should be plainly marked on the side every 3 or 6 inches, in order to correctly measure the amount of liquid.

SMALL PORTABLE VATS FOR SMALL FLOCKS.

If no regular dipping vat is at hand a good-sized tub may be used, as shown in fig. 10. Dipping in this manner is slow and tedious, but may be resorted to in case of necessity, as, for instance, when a few sheep are bought from another flock which is not known to be absolutely free from scab. If care is taken to dip thoroughly the dipping may be done as effectually in such a tub as it could be done in a large vat. Recourse to ordinary tubs is not advised, however, when it is possible to use regular dipping vats. Lambs may, in case of necessity, be dipped in troughs, as shown in fig. 11.

A small portable vat, suitable for use in dipping small flocks, is shown in fig. 12. When not in use this vat may be conveniently stored away. An advantage connected with this vat is that it may be drawn from place to place as desired. The dimensions here given may be varied, according to individual taste, by making the vat longer, broader, or deeper. A convenient size will be 9 feet long by $2\frac{1}{2}$ feet broad at the top, 9 inches broad at the bottom, and $3\frac{1}{2}$ to 5 feet deep; the floor measures 9 inches broad by 4 feet long; from 1 foot above one end of the floor a slant with cross cleats rises to the top and end of the vat. The sheep are dropped in by hand, one at a time, at the deep end, and after being held in the dip for two minutes are allowed to leave the vat at the slanting end. They are held a moment on the slant to allow them to drain off, thus economizing in dip. A gate may be placed at the deeper part of the slant if desired, in order to save labor. This gate should swing toward the exit of the vat. Such a tank may be made of $1\frac{1}{2}$ -inch pine boards, with tongue and groove, and should be well pitched or painted.

This plan of vat may be easily modified, if desired, so as to have a small dripping pen attached, as shown in figs. 13 and 14. In this modified plan an inclined platform is added to the vat shown in fig. 12 and a removable skeleton box is made to fit over it. While one sheep is being dipped another sheep is allowed to ascend the incline into the small dripping pen. When the sheep is sufficiently drained the gate is opened, it leaves the pen, the gate is closed, the sheep in the vat enters the pen, and another sheep is placed in the vat.

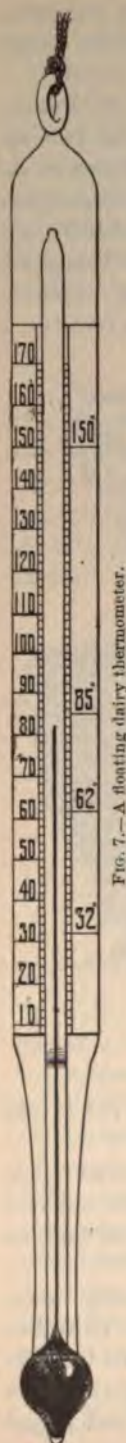


FIG. 7.—A floating dairy thermometer.

A small portable vat used in some places is shown in figs. 15 and 16. Dipping in a vat of this kind may be thorough, but is tedious.

Another style of small vat suitable for holding three sheep at a time is shown in fig. 17. It is estimated that 1,500 sheep may be dipped in this tub in a single day. The dimensions of the plant are given in the diagram, and need no further explanation.



FIG. 8.—A crutch, or dipping fork. (Copied from the *Agricultural Journal*, 1894, p. 261.)



FIG. 9.—Another style of crutch, or dipping fork.

MORE PERMANENT PLANTS FOR LARGER FLOCKS.

RECEIVING AND FORCING YARDS.

Where large numbers of sheep are to be dipped, it is necessary to build receiving pens close to the dipping vat. The number and size of the pens vary with the number of sheep to be handled. The yards



FIG. 10.—Dipping sheep in a tub. (Copied from Stewart's *The Shepherd's Manual*, 1882, p. 47.)

may be either square or oblong, as shown in figs. 17 and 18, or they may be circular, as shown in fig. 19. The square or oblong yards are the more simple in construction and need no detailed description, as all details may be seen by consulting the diagrams. The circular yard, however, needs a word of explanation.



FIG. 11.—Trough for dipping lambs. (Copied from Stewart's *The Shepherd's Manual*, 1882, p. 48.)

In using the circular yards (fig. 19) two natural habits of the sheep are turned to practical account, so as to lessen the work of driving, namely, the habit sheep have of "ringing" when disturbed in a yard, and the tendency they show to escape at the point where they enter an inclosure.

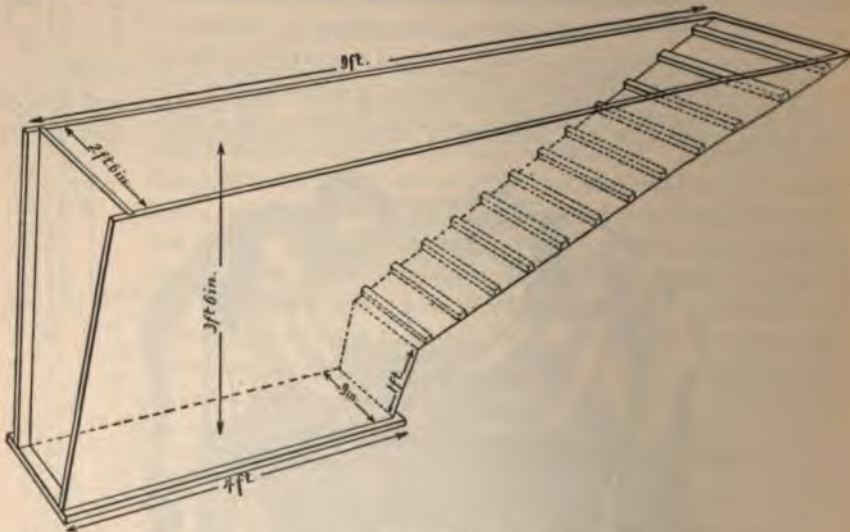


FIG. 12.—A small portable dipping vat for small flocks.

The flock is yarded at *AB* and find its way into yards 1 and 2 through the openings *CD* and *CE*. When these yards are full the gates *CD* and *AB* are closed to form yard 6. The sheep then circle through yards 3, 4, 5, and 6, coming to the point at which they entered

and expecting to escape. When yards 3, 4, 5, and 6 are filled the other gates are closed, so that the sheep can not return to yards 1 and 2. If

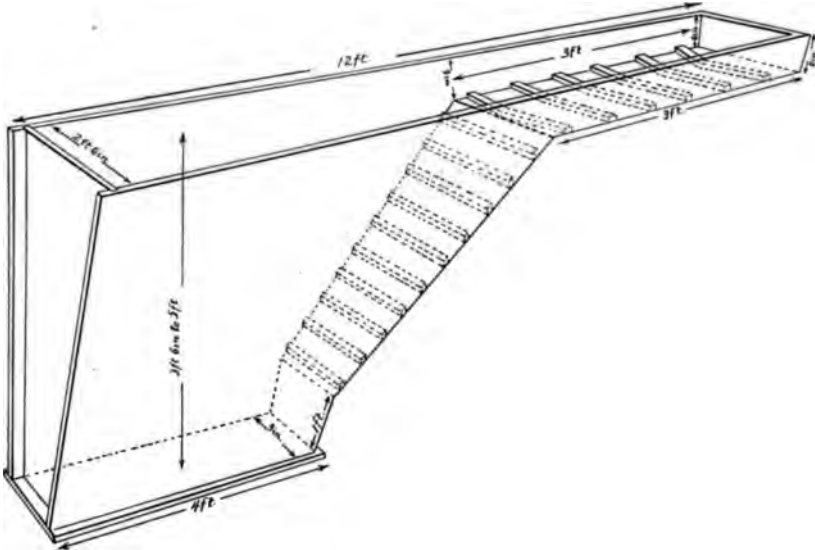


FIG. 13.—A small portable dripping vat with attached dripping platform.

the animals hesitate to enter yards 3, 4, 5, and 6, another natural tendency of the sheep may here be turned to account. A man jumps over the fence and runs through the flock in the opposite direction (6, 5, 4, 3)

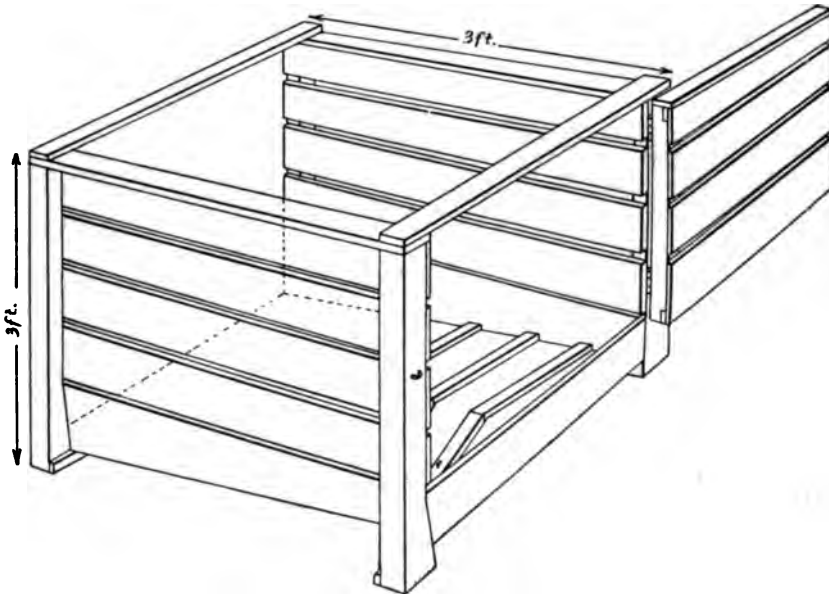


FIG. 14.—Detachable skeleton box, with gate, to sit over the dripping platform shown in fig. 13.

to that in which the animals are wanted to move. This will generally result in starting the sheep in the desired direction.

From the exit of yard 6 (*BC*) there should be built a narrow run extending to the dipping vat. This run should be about 20 feet long by 2½ feet wide, and should be provided with sides high enough, espe-



FIG. 15.—A small patented portable vat arranged as a cart. (Copied from Armatage, 1895, *The Sheep Doctor*, p. 491.)

cially near the vat, to prevent the sheep from jumping over and thus escaping. These sides should be continued a short distance along both sides of the vat. The last 5 feet of this run should slant downward toward the vat at an incline of 25 to 30 degrees, and should be

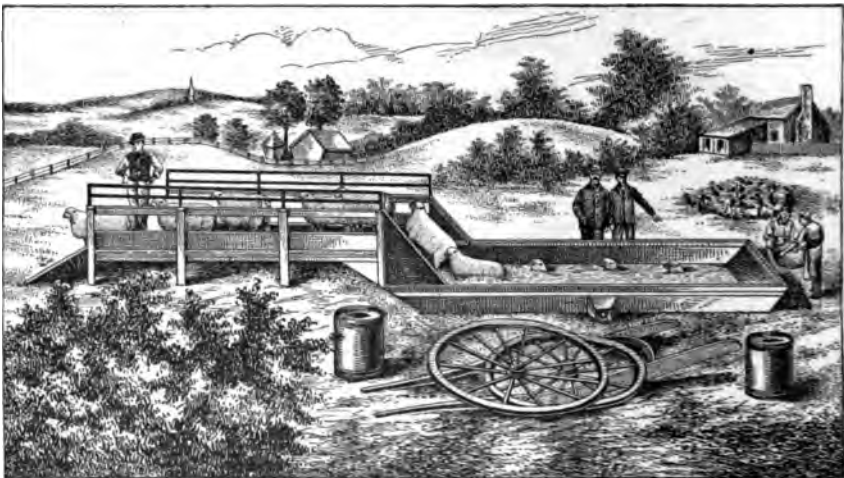


FIG. 16. Portable vat unfolded and in use. (Copied from Armatage, 1895, *The Sheep Doctor*, p. 491.)

smooth. By pouring upon it some of the dip it may be made slippery so that the sheep will slide into the vat. If there is no natural incline toward the vat, an incline may easily be made by raising the floor of

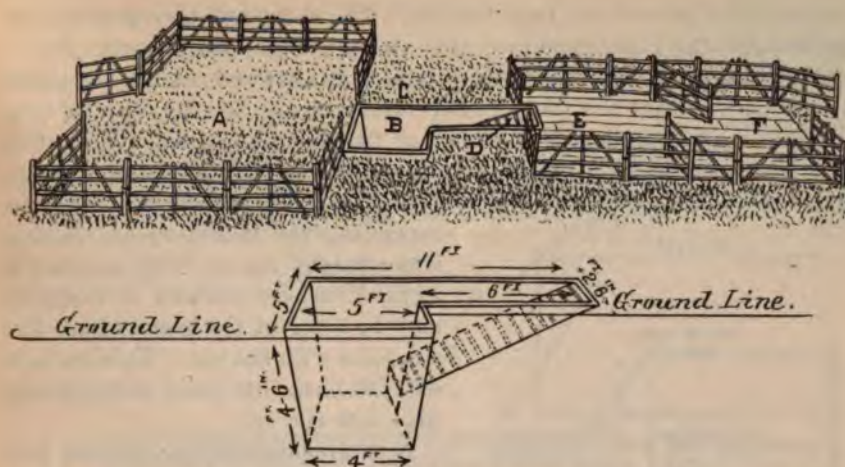


FIG. 17.—A small dipping plant: A, collecting yard; B, dipping vat; C, place for man with fork; D, incline, with cross cleats, to draining pens E and F. Lower diagram gives dimensions of the vat. (Copied from Sutherland's Sheep Farming, 1892.)

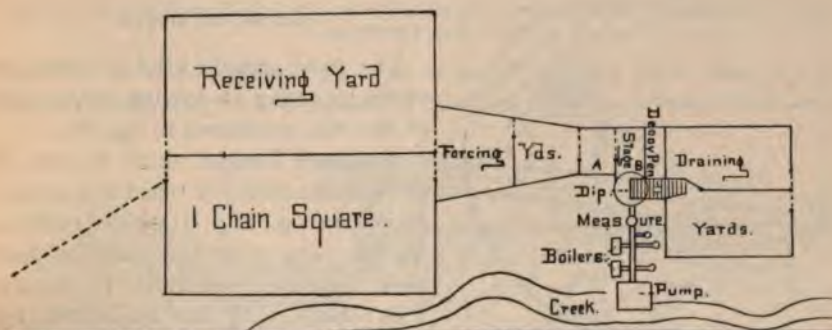


FIG. 18.—Receiving and forcing yards, with attached stage, decoy pen, vat, draining yards, etc. Scale 50 by $1\frac{1}{4}$ inches. (Copied from Bruce's Scab and Its Cure, 1894, p. 17.)

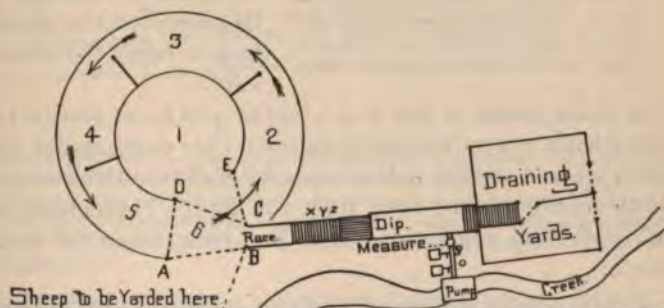


FIG. 19.—Australian circular receiving and forcing yards, with straight race or drive, the incline chute, straight vat, incline, two draining pens, etc. Scale 50 feet to $1\frac{1}{4}$ inches, making the outer circle of the yards about 66 feet in diameter. (Copied from Bruce's Scab and Its Cure, 1894, p. 17.)

the run at a point 5 feet from the vat. The sheep will then pass up the incline *x* to the highest point *y*, then down the incline chute *z*.

Much time will be saved in dipping if the yards and run are arranged in such a way that the sheep in the race can not see the dipping vat. This can be accomplished by either of two simple methods: First, the run, instead of being straight, may be built with a sudden angle at the point *y* (see fig. 19); the vat will then not be visible to the sheep

ascending the incline *x*; or, second, if a straight run is built as shown in fig. 19 a loose curtain of bagging may be hung at the point where the run joins with the vat. This curtain will fall back into place as the sheep drop into the vat.

A modification of the circular pen is seen in fig. 20, taken from Gibson's (1893) *History and Present State of the Sheep Breeding Industry in the Argentine Republic*.

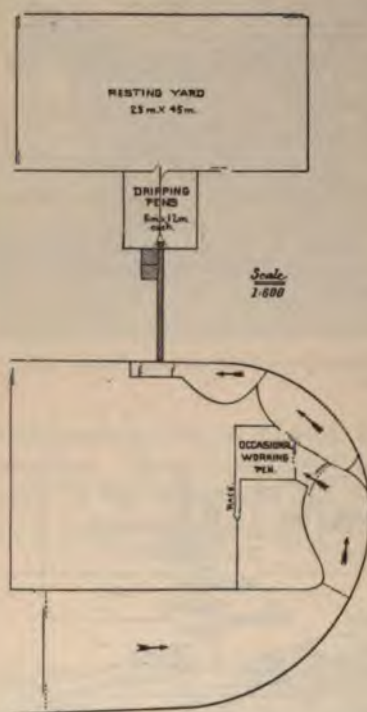


FIG. 20.—Argentine semicircular receiving and forcing yards, with a straight vat, draining pens, etc. The dimensions are given in the metric system: 1 m. (meter) equals 39.36 inches. (Copied from Gibson's *History and Present State of the Sheep-Breeding Industry in the Argentine Republic*, 1893.)

CHUTES, OR SLIDES.

The most simple kind of chute is made by using an incline at the end of the run, as shown in fig. 19.

A second kind of chute in use is the endless-chain or treadmill chute, shown in fig. 21. Its construction can be seen from the diagram and need not be described in detail. This chute may be improved by building it on a slant toward the vat, in which case a bolt or other arrangement must be attached to stop the chute when desired; the weight of the sheep on the movable chute will help to carry the animals toward the vat.

A third chute in use is a pivoted platform, shown in fig. 22. The sheep walk out on the platform until they overbalance its free end, and then, when a sliding bolt is removed, fall into the tank. The structure of the chute may be seen from the figure. Accidents are more likely to result from using this chute than from using the slant or the chain chute.

For dipping pregnant ewes some persons build a movable platform which can be lowered into the vat and raised at will.

THE DIPPING VAT.

The dipping vat may be made on several different plans: The single oblong straight vat; the double or triple, with turns at the ends; the

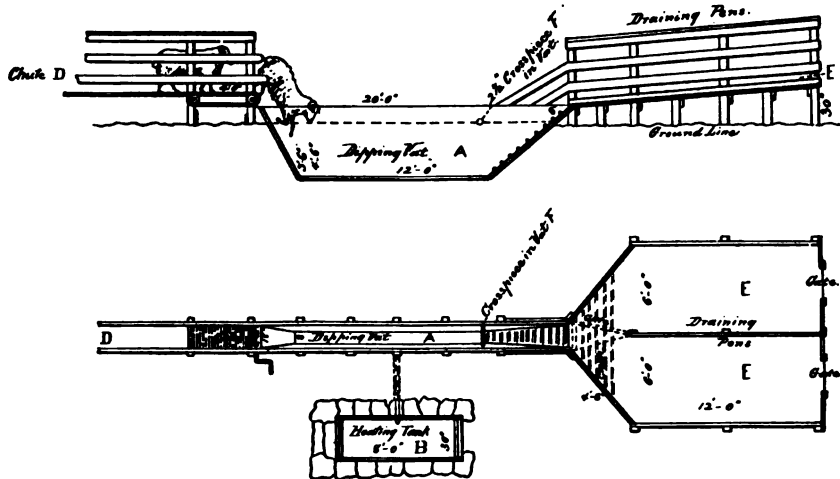


FIG. 21.—Dipping plant provided with an endless-chain or treadmill chute. (Copied from the American Sheep Breeder, 1891.)

square; or the circular. In case of single oblong vats, time will be saved in dipping if a long vat is used, so that the animals may swim

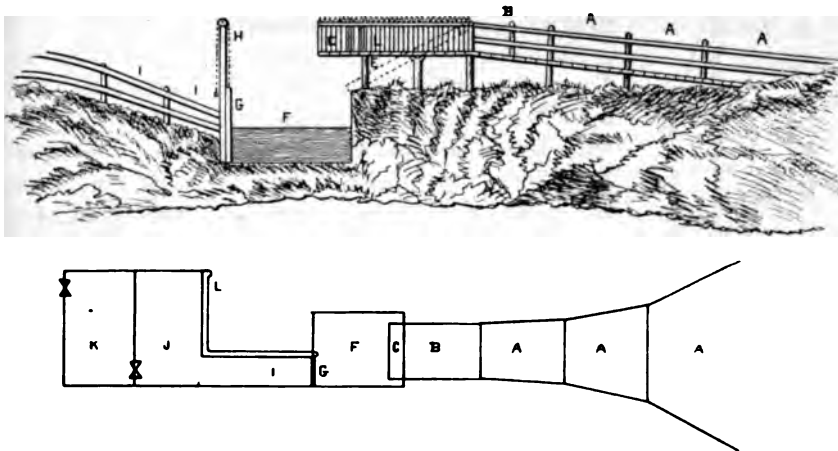


FIG. 22.—Dipping plant illustrating: A, collecting and forcing yards; B, straight drive; C, decoy pen in which several sheep are kept; D, dipping pen with pivoted floor E, secured by a bolt; by withdrawing the bolt the sheep are precipitated into the square tub F; G, sliding gate through which the sheep pass from the tub to the draining pens, J and K; L, channel for drip, conducting the ooze back to the vat. The lower diagram gives a surface view of the upper figure. (Copied from the Veterinarian, 1862, p. 333.)

directly through without stopping, and then leave the tank. Very naturally the longer the vat the more building material and ooze will be required. Vats are in use varying from 10 to 120 feet long.

The single oblong vat.—Single oblong dipping vats are shown in figs 18, 19, 20, 21, 23. These tanks should be made about 2½ feet broad

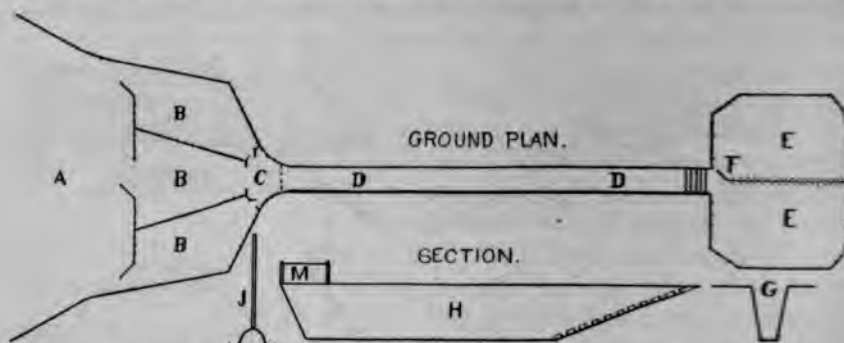


FIG. 23.—A, collecting yard for the sheep which are to be dipped; B, B, B, small pens leading to an inner pen with an inclined chute, or in which a man may stand to pass the sheep one at a time into the vat; D, D, the tub, which should measure from 20 to 120 feet long, 21 to 30 inches broad at the top, 6 to 9 inches broad at the bottom; M, board 2 feet high on each side of the entrance of the vat to catch the splash and to prevent the sheep from escaping; E, E, draining, or dripping, pen; F, swinging gate; G, cross section of the tub; J, crutch for keeping the backs of the sheep under the surface, and for catching or holding sheep in the dip. (This drawing is taken from the *Agricultural Journal*, III, 1891, p. 236; it was also published in the *American Sheep Breeder*, Feb. 1, 1892.)

the top, 9 inches broad at the bottom, and 4 to 5 feet deep; the length may be 20 to 120 feet, as desired. One end (the entrance) should be

straight, as shown in figs. 24 and 26, or with a steep slant, as shown in figs. 21, 23, and 25, while the last 5 to 14 feet at the other end (exit) should have a gradual slant with cross cleats.

The square vat.—A square vat is shown in fig. 22. This tub should be 5 feet deep, and large enough to hold 10 or 12 sheep at a time. The square vat does not present any particular advantages over narrow oblong vats, except that it gives the sheep an opportunity to swim around. This kind of a vat is not in very general use among large herders.

The triple vat.—In the triple vat (fig. 28) the sheep come through the run, or drive, and slide into the first vat at A; swimming in the direction of the arrows they round the turns B and C, ascend the incline D, and enter the draining pens. The theory upon which this triple vat is used is that upon rounding the point B the sheep bend toward the left, thus crumpling the scabs on the left side and opening the wool on the right; upon rounding the point C they bend toward the right, crumpling the scabs of that side and opening the

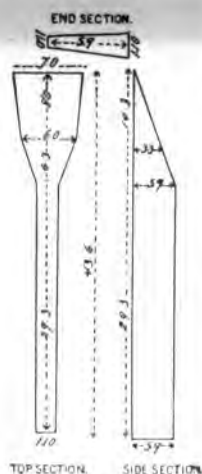


FIG. 24.—A straight vat known as the Australian sheep dipping tank.

This vat is in use at Tuleumbah station, New South Wales, and gives much satisfaction. The swimming race is 29 feet 3 inches long, 1 foot 10 inches wide at top, with gradual inward slope to 11 inches at the bottom, and 5 feet 9 inches deep; the landing stage (slant) is 14 feet 3 inches long (surface measurement), with a rise of 5 feet 9 in 14 feet 3 inches. To allow for any weak sheep, which stand in the way and block the others at the end of the swim, the landing stage opens out from 1 foot

wool on the left. This is evidently a more theoretical than practical consideration.

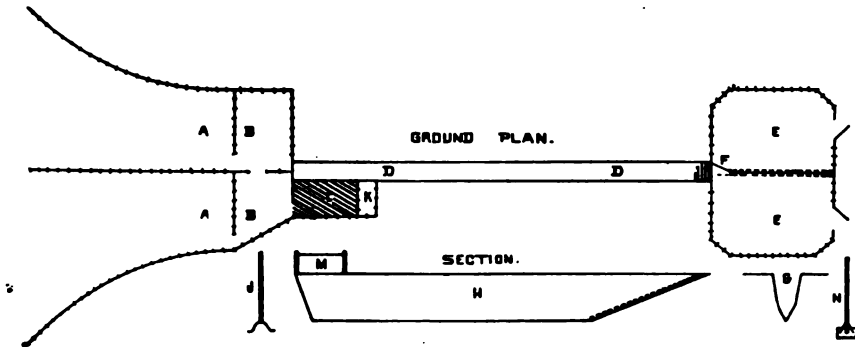


FIG. 25.—A somewhat similar straight swim taken from Sutherland's Sheep Farming: A, collecting pens; B, B, smaller pens; C, small pen at the side of the vat; K, decoy pen in which several sheep are placed to induce the sheep in pen B to enter pen C; D, D, a tub 50 to 60 feet long, 5 feet deep, 21 inches broad until 3 feet from the top, then narrowing to 6 or 8 inches at the bottom, as shown in the cross section; G, M, a board 2 feet high to catch the splash; the last 18 feet of the swim slants gradually, with cross cleats, to the draining pens, as seen in H; E, E, draining pens, worked alternately with the swinging gate, F; each pen measures 24 by 15 feet, and should slant toward the vat; J, crutch 5 or 6 feet long; N, mixer for stirring the liquid.

Each run should be about 15 to 30 feet long and $2\frac{1}{2}$ feet broad; the tank should be $4\frac{1}{2}$ to 5 feet deep and 4 to $7\frac{1}{2}$ feet wide at the bottom.

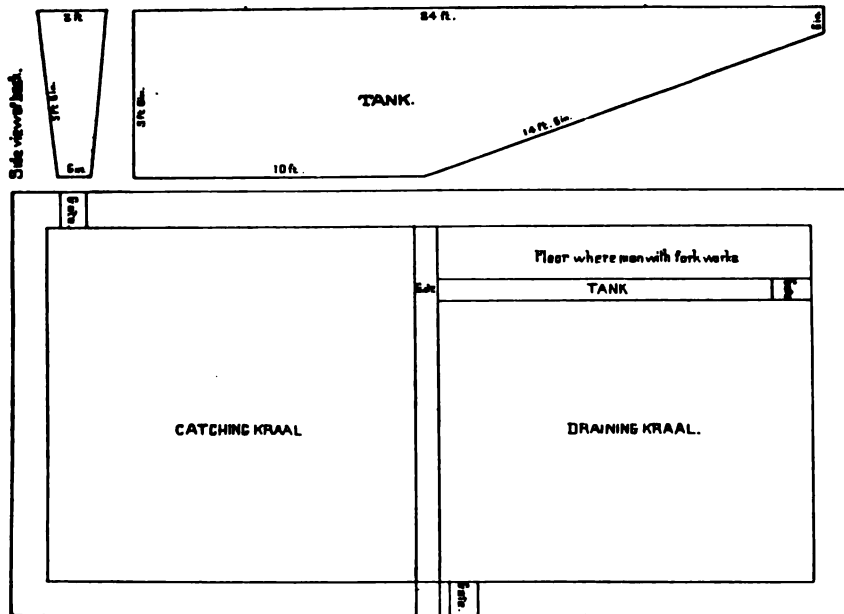


FIG. 26.—A dipping plant figured in the Agricultural Journal, 1894, p. 620, in use in South Africa.

At the point A, where the sheep fall into the swim, it is best to have the floor of the first run $2\frac{1}{2}$ feet wide for a distance of 6 feet, in order

10 inches at top and 11 inches at bottom to a width (top and bottom) of 6 feet at a distance of 6 feet 3 inches (longitudinally) from the end of the swimming race, and gradually widens for the remaining 8 feet of length to a width of 7 feet at the end.

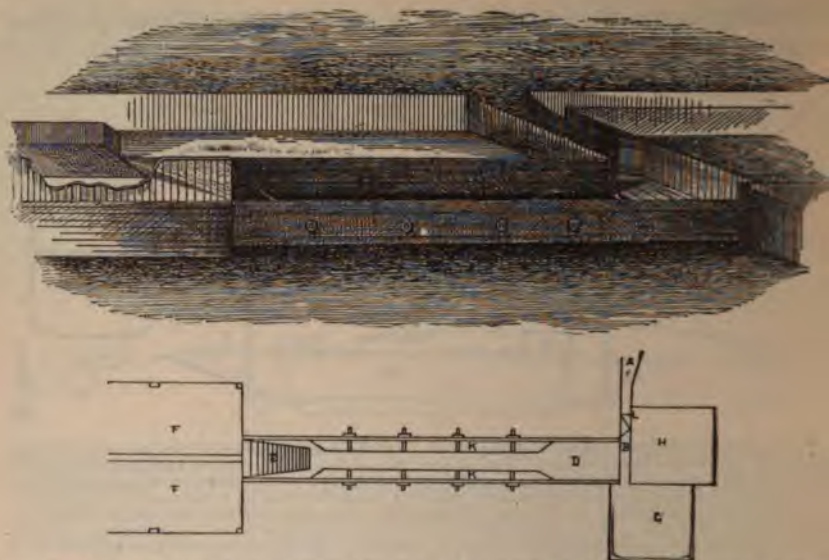


FIG. 27.—A dipping plant in use in Millard County, Utah. A, chute from the large corral; B, a sliding board over which the sheep in attempting to pass to the decoy pen, C, slide into the tank; K, K, two pieces, 2 by 6 inches and 12 feet long, bolted lengthwise of the tank, leaving a 12-foot space in the middle of the dip through which the sheep must put their heads, preventing those rear from riding those in front, at the same time keeping their backs under the dip. (Copied from Powers' *The American Merino*, 1887, p. 308.)

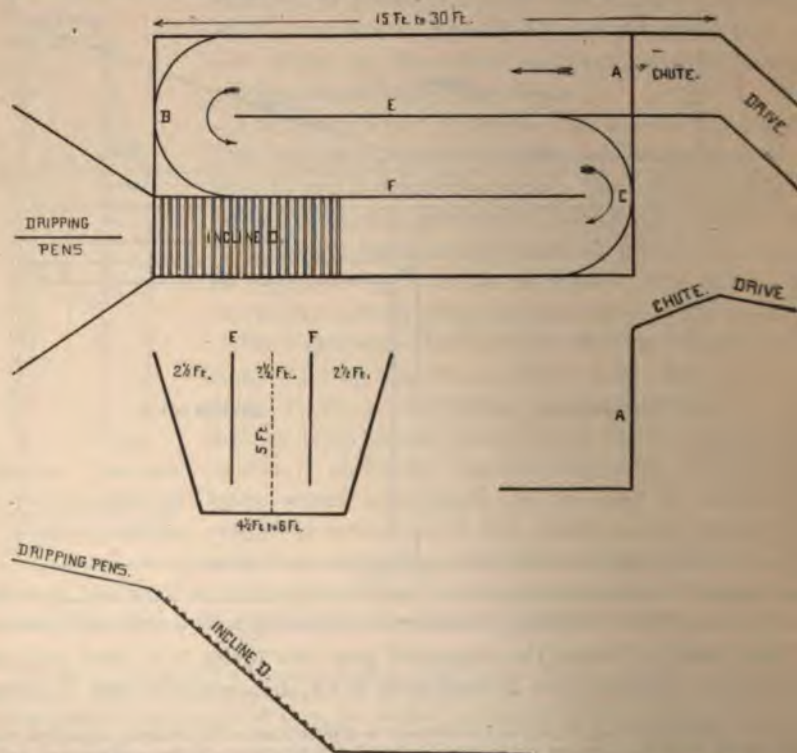


FIG. 28.—A triple vat. The various diagrams give surface view, cross section, vertical section entrance to the vat, and vertical section of the incline and dripping pens.

to prevent accidents, but beyond that distance the floor may be narrowed in order to save the dipping fluid. If the partitions *E* and *F* are not made solid the ooze will circulate more easily and thus remain at a more even temperature; the boards should be close enough together, however, to prevent the sheep from catching their feet in the cracks. A gate should be arranged at *D*, so that the animals may be delayed in the ooze, if desired. (See also fig. 36 of the triple vat in use at the Chicago Stock Yards.)

The circular vat.—Some parties prefer a circular vat (fig. 29). The advantages set forth in favor of this are, first, a fewer number of men are required to attend to the animals in the tub; second, where it is

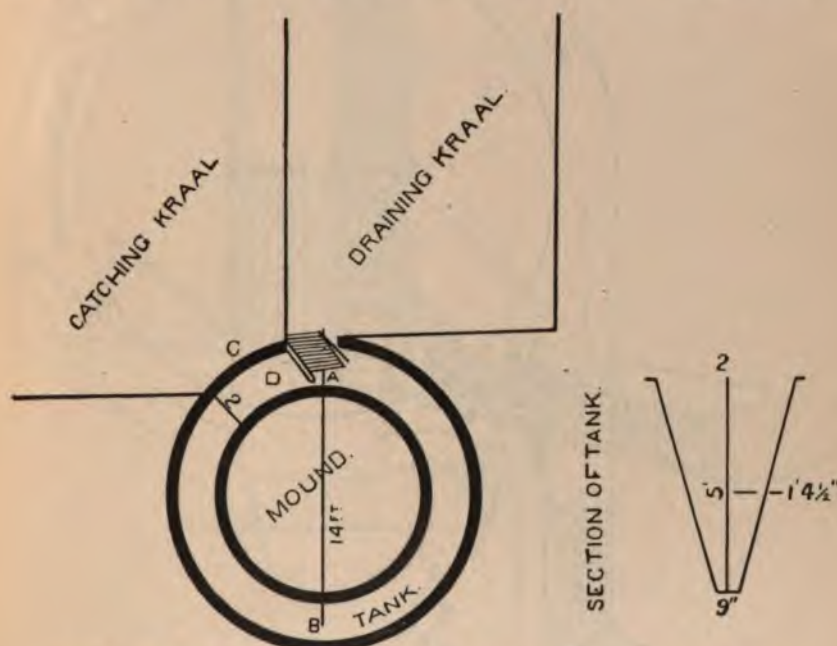


FIG. 29.—A circular dipping tank. (Copied from the Agricultural Journal, 1895, p. 119.)

desired to give any particular sheep an extra long swim, this may be done by quickly closing the gate *D* at the exit, thus compelling the animal to swim around again, without delaying the other sheep; third, by building a circular vat with a circumference of 30 feet the animals may be made to swim around two, three, or four times, thus gaining the advantage of a tank 60, 90, or 120 feet long, yet with a much smaller amount of building and dipping material.

The vat should be $2\frac{1}{2}$ feet broad at the top, 9 inches broad at the bottom, and 5 feet deep. To determine the circumference multiply the diameter by 3.1416.

Despite the advantages of the circular tank in saving material and obtaining the advantages of a long swim, there are two rather serious

objections to it: First, in the vat as shown in fig. 29, it is necessary to throw the animals in by hand, since a chute directed into the circle would lead to accident; second, the circular vat is much more difficult of construction than the straight vat.

These objections may, however, be overcome in several ways, still preserving all the advantages. If a circular vat is preferred and a

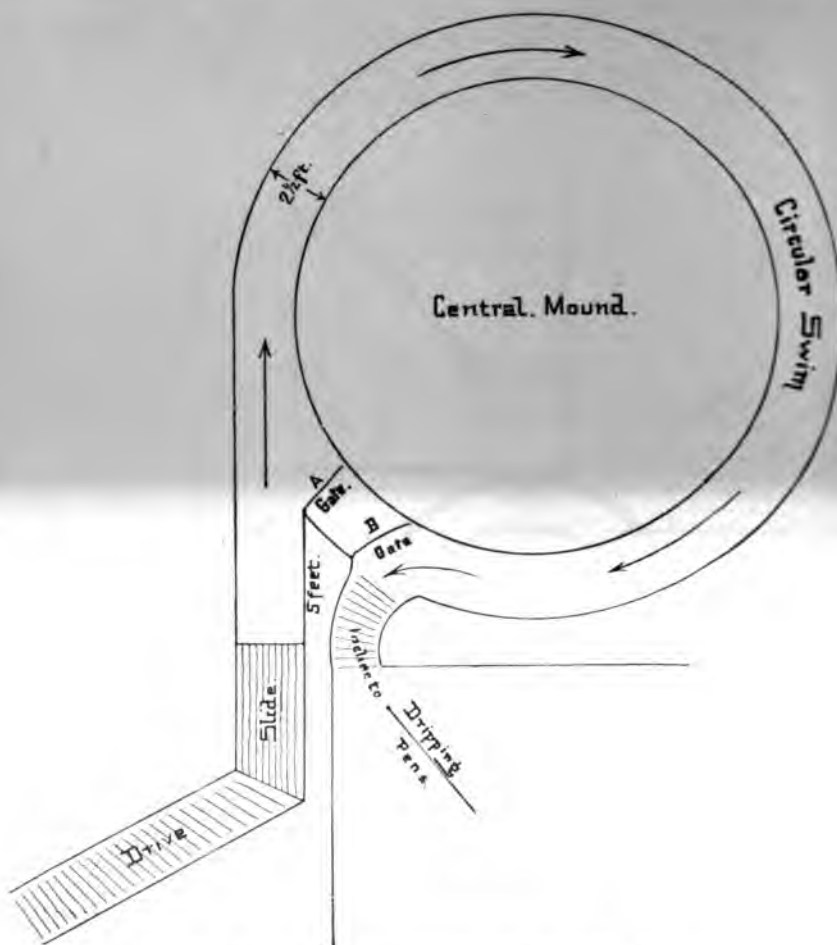


FIG. 30.—A circular dipping tank, with drive and slide.

chute is desired, the object may be attained by building a short, straight vat on a tangent to the circle, as shown in fig. 30. In this case, two swinging or sliding gates, *A* and *B*, will be required.

The double vat.—All of the advantages of the circular vat may be combined with the easy construction of the straight vat by building a straight tub with a double channel, as shown in figs. 31 and 32, the

second swim being prolonged in an incline to the draining pens. Such a vat may be constructed as follows:

Build an oblong tub 15 feet long, 5 feet deep, 5 feet wide at the top, and 3 to 5 feet wide at the bottom. Running lengthwise through the center, build an upright, partially open, partition 10 feet long and $4\frac{1}{2}$ feet deep (measured from the top of the tub), leaving an open space of $2\frac{1}{2}$ feet at each end and 6 inches at the bottom; this partition is supported by three uprights running to the floor of the tub, and cross supports may be placed on top of the tub at any point except near the entrance of the

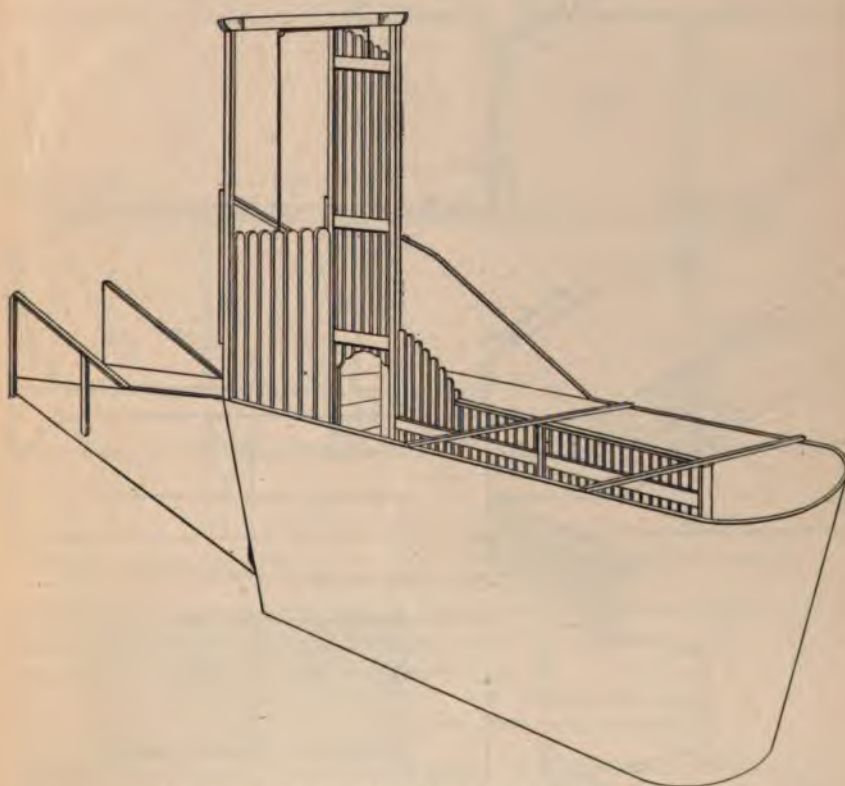


FIG. 31.—View of double oblong swim. (Consult also fig. 32.)

swim. A gate is hung at one end between the slide (entrance) and the incline (exit), and should extend above the tub, in order to prevent the sheep from jumping over the middle partition into the second swim; it should extend down to within about 6 or 12 inches of the floor of the tub. When this gate is closed against the middle partition the sheep will leave the vat by the incline to the draining pens; when it is closed against the incline, the sheep can be forced to swim around the tub two or three times, as desired. Or, in place of a swinging gate, two sliding gates may be arranged to run up and down in grooves, balancing each

other or each balanced separately by weights. One of these gates is placed between the end of the vat and the end of the middle partition, the other is placed at the entrance of the incline to the draining pens.

By constructing the double vat and sending the sheep around three times there would result, first, a saving in the original cost of the tank when compared with a 90-foot straight swim; second, a saving in space; third, less than half as much dip would have to be kept warm at a time; fourth, less than half as much dip would have to be made

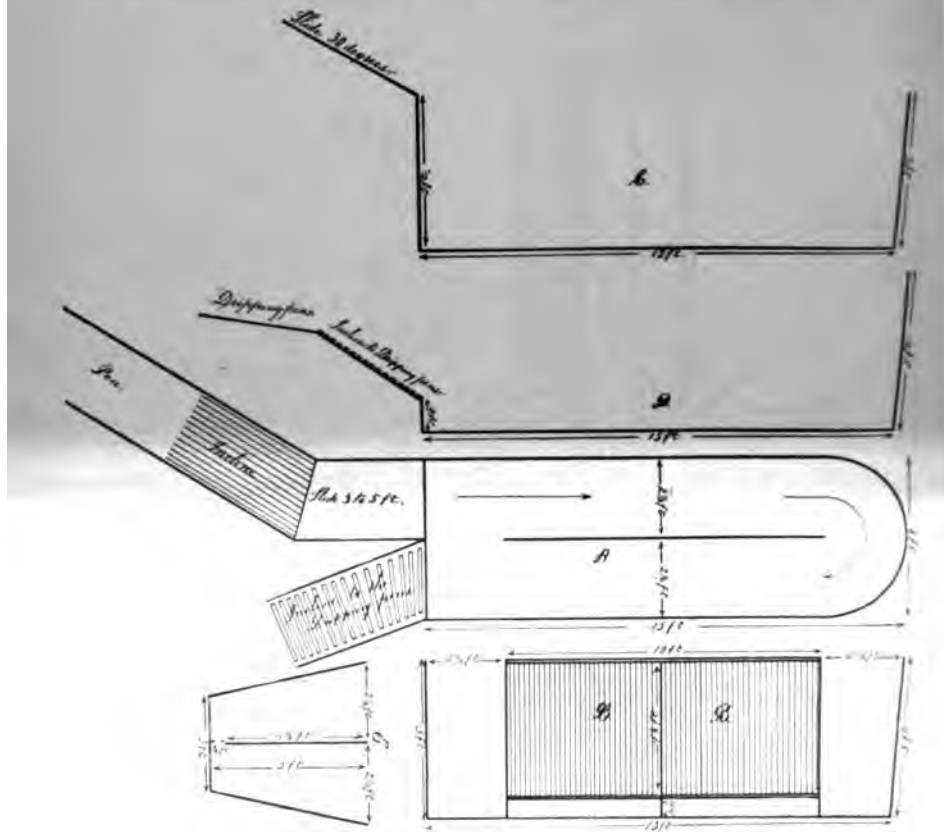


FIG. 32. — A double oblong swim: *A*, ground plan; *B*, side view of the middle partition; *C*, longitudinal section of the first swim; *D*, longitudinal section of the second swim, with incline; *E*, cross section of the entire vat, with partition in the center.

up at a time; fifth, the residue after dipping would be reduced and thus the loss decreased. It would, however, take a longer time to dip a large flock of sheep in such a vat than in a straight vat 90 feet long.

THE INCLINE TO THE DRIPPING PENS.

At the end of the vat an incline, with cross cleats, is built so that the sheep may leave the dip of their own accord and enter the draining pens. A board fence, 2 feet high above the top of the vat, should run

a few feet each side of this incline to prevent the sheep from escaping. These inclines are shown in figs. 21, 23, 25, and 26; the rise for fat heavy wool sheep must not be too steep, otherwise the exertion will be too great. In fig. 24 the incline is 5 feet 9 inches in a surface distance of 14 feet 3 inches. At the Chicago Stock Yards the incline is 9 feet.

Much labor will be saved if a hinged or, still better, a sliding gate

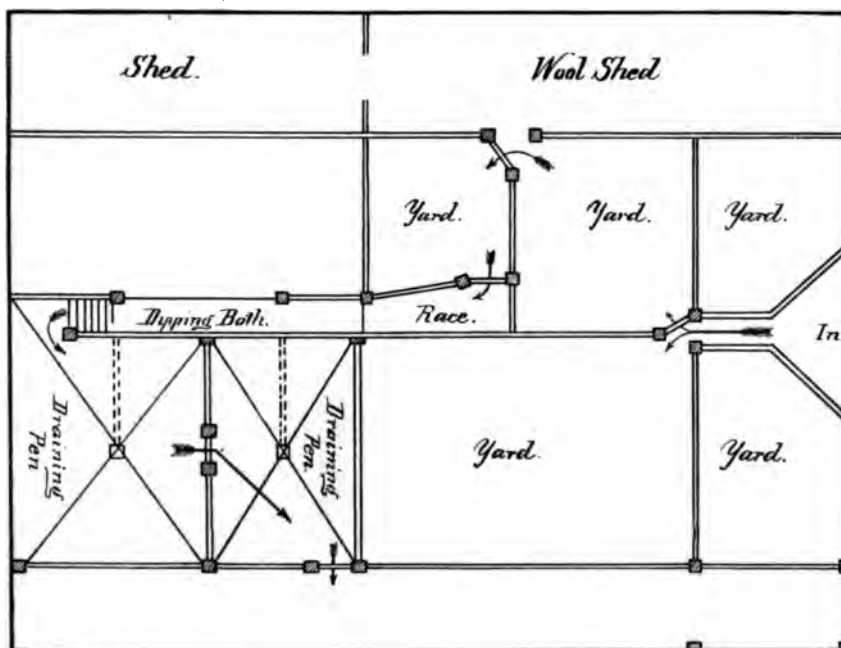


FIG. 33.—Ground plan of yards and vat. (Copied from Armatage, 1895, *The Sheep Doctor*.)

is placed at the deepest portion of the incline. The sheep may thus be held in the dip as long as desired; when the time is up the gate is opened and the sheep enter the draining pens.

THE DRIPPING PENS.

There should be two dripping pens side by side (figs. 17, 18, 21, 23, and 33) with a swinging gate at the entrance; one is filled, the gate is then closed, opening the other pen; when the second pen is filled the first pen is emptied; or the pens may be in direct line with the vat (figs. 17 and 22).

These pens should have a slight incline toward the tub so that the dripping ooze will run back to the tub. A good plan is to build the incline from the sides toward the center fence; under the fence build a partially covered gutter inclining to the tub; the cover of the gutter should be removable to allow cleaning; at the end of the gutter nearest the tub place a grating to catch the wool and droppings, thus preventing these materials from being washed into the dip.

SHELTER FOR THE DIPPING PLANT.

The vat, boilers, and dripping pens should be under cover, and it will be well to extend the cover over the drive and the forcing pens.

ARRANGEMENTS FOR CLEANING.

Cleaning the plant may be facilitated if the following suggestions are observed: It is well to have one end of the vat slightly lower than the other end, so that the ooze will run toward that point when the tub is being emptied. If the entire floor of the collecting pens is made of brick, cement, or boards, and inclines slightly toward one or two points, the yards may be more easily cleaned by means of a hose and

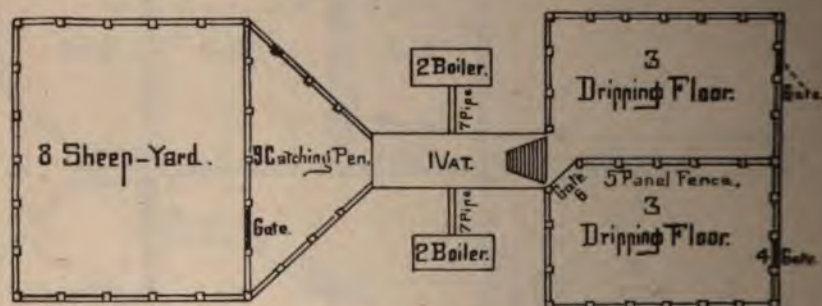


FIG. 34.—Ground plan of yards and vat. (Copied from Powers' *The American Merino*, 1887, p. 284.)

stream of water. If this plan is adopted there should be an upright baseboard or a solid wall of concrete or brick a few inches in height running around the edge of the entire pen. If there is direct sewer connection for the vat a trap or manhole should be made to catch the droppings and the tags of wool, otherwise the sewer pipe will become obstructed.

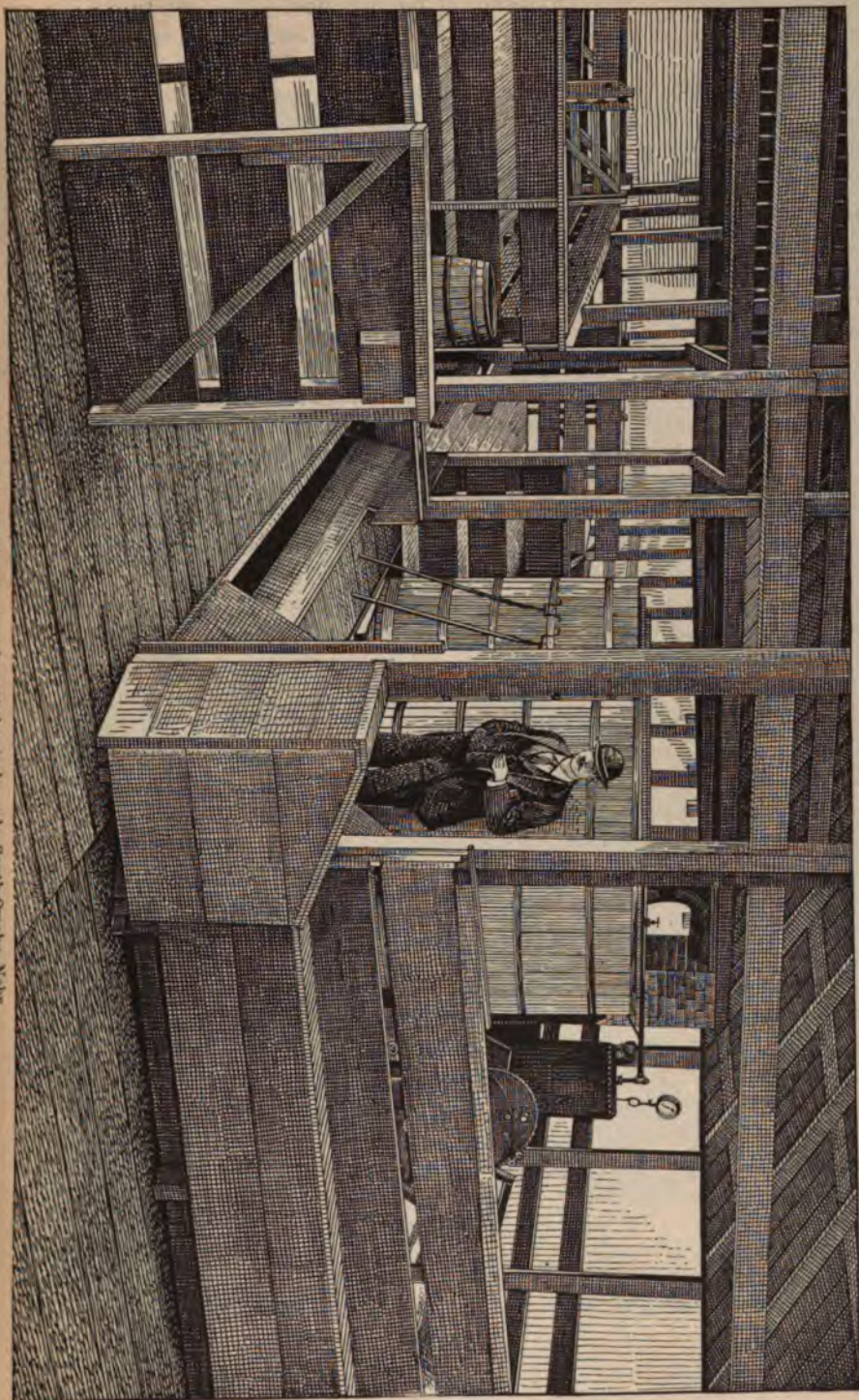
BOILING, INFUSING, AND SETTLING TANKS.

The arrangement of the boiling tanks depends upon two factors in particular: First, upon the kind of dip used; second, upon the arrangement adopted for keeping the bath at the proper temperature.

In case a steam pipe is placed near the floor of the dipping vat in order to keep the ooze at its proper temperature while dipping, the vat itself may be used for heating water. Clear water is run into the vat and the steam turned on full force until the proper temperature is obtained. If a carbolic or a prepared tobacco dip is used, the material may then be mixed in the vat if desired. Even in this case, however, it is best to provide a separate boiling tank for heating and preparing fresh ooze to replace the dip as it is used up.

These boiling tubs may be made of wood or iron, according to facilities at hand. If steam is to be had, the square or round wooden boiling tub may be used, and an open steam pipe run into it to heat the water. If the steam pipe can not be used, either in the vat or

FIG. 35.—View of the dipping plant at the stock yards, South Omaha, Neb.



the boiling tanks, iron tanks should be provided. The iron tanks are set in brick or stone frames, with a fireplace below. It is best to have two tanks, each with a capacity of about 400 gallons.

If a homemade tobacco dip is prepared from the leaves there should also be provided two iron infusing caldrons, each with a cover and with a capacity of 80 to 120 gallons. The infusion is prepared in these smaller tanks, while the bulk of the water is heated in the boiling tanks or in the swim itself.

If a lime-and-sulphur dip is used it is absolutely necessary to provide some means for settling the mixture, in order that the bath may be free from sediment. This may be done in two ways. The better way is to have separate settling tubs provided with bungholes or pipes three or four inches from the bottom. After the mixture is thoroughly boiled it is pumped into the settling tubs and allowed to remain there until it is perfectly free from sediment; the clear liquid is then run into the dipping vat and diluted with warm water to the proper strength. Or the boiling tanks may also be used as settling vats. A pipe with elbow joint is run into the boiling tank three or four inches above the bottom; the opening of the pipe should point sidewise, not up. After boiling the proper length of time the fire is removed and the liquid allowed to stand until clear; only the clear ooze is drawn off, the sediment remaining on the floor of the boiling tank.

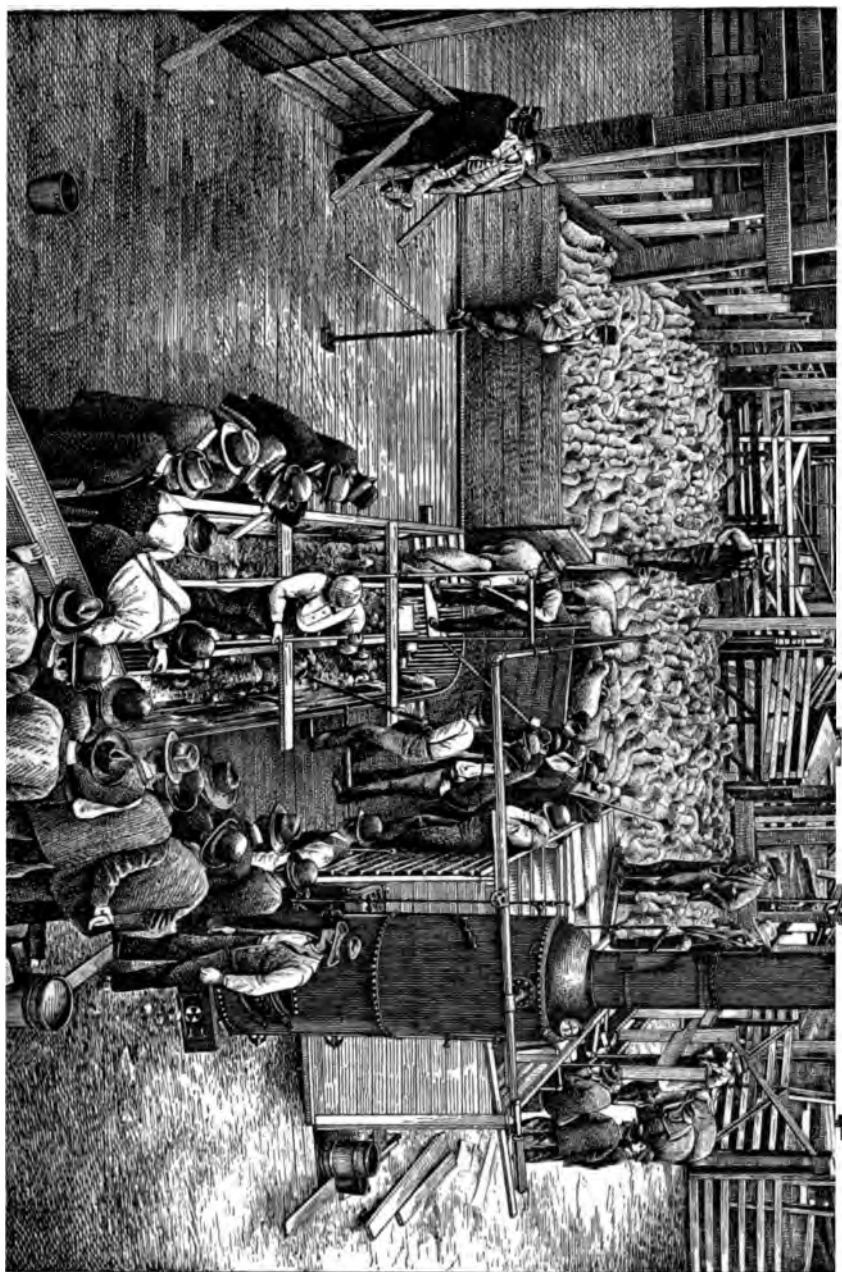
MEASURES.

The capacity of the vat should be marked at different depths. The capacity of the boilers should also be marked in the same way. If these are marked for every 100, 200, 300, or 500 gallons (according to the amount of dipping to be done), separate measuring tanks will be unnecessary. In case the tanks are not marked a separate measuring tank should be provided.

If a homemade tobacco dip or a lime-and-sulphur dip is used a set of scales is necessary. To guess at weights in mixing lime and sulphur may result in too strong a dip.

PUMPS.

A portable pump will be found of great use in filling and emptying tanks.



FEDERAL LAWS AND REGULATIONS RELATIVE TO SHEEP SCAB.

As the scab of the sheep is unquestionably a contagious disease, it is unlawful to ship sheep so affected from any State, Territory, or the District of Columbia into any other State, Territory, or the District of Columbia. The penalties for such shipment of diseased sheep are heavy, as will be seen from an examination of sections 6 and 7 of the act approved May 29, 1884, which are as follows:

SEC. 6. That no railroad company within the United States, or the owners or masters of any steam or sailing or other vessel or boat, shall receive for transportation or transport, from one State or Territory to another, or from any State into the District of Columbia, or from the District into any State, any live stock affected with any contagious, infectious, or communicable disease, and especially the disease known as pleuro-pneumonia; nor shall any person, company, or corporation deliver for such transportation to any railroad company, or master or owner of any boat or vessel, any live stock, knowing them to be affected with any contagious, infectious, or communicable disease; nor shall any person, company, or corporation drive on foot or transport in private conveyance from one State or Territory to another, or from any State into the District of Columbia, or from the District into any State, any live stock, knowing them to be affected with any contagious, infectious, or communicable disease, and especially the disease known as pleuro-pneumonia: *Provided*, That the so-called splenetic or Texas fever shall not be considered a contagious, infectious, or communicable disease within the meaning of sections four, five, six, and seven of this act, as to cattle being transported by rail to market for slaughter, when the same are unloaded only to be fed and watered in lots on the way thereto.

SEC. 7. That it shall be the duty of the Commissioner of Agriculture to notify, in writing, the proper officials or agents of any railroad, steamboat, or other transportation company doing business in or through any infected locality, and by publication in such newspapers as he may select, of the existence of said contagion; and any person or persons operating any such railroad, or master or owner of any boat or vessel, or owner or custodian of or person having control over such cattle or other live stock within such infected district, who shall knowingly violate the provisions of section six of this act, shall be guilty of a misdemeanor, and, upon conviction, shall be punished by a fine of not less than one hundred dollars nor more than five thousand dollars, or by imprisonment for not more than one year, or by both such fine and imprisonment.

The provisions of this statute are very specific and clear, and there can be no possible doubt of their application to the disease under consideration. Congress has, nevertheless, gone still further by way of emphasizing this application, and has particularly directed the attention of the Department of Agriculture to a few important diseases, including sheep scab, by the following clause, which has been repeated in the appropriation act for a number of years:

* * * and the Secretary of Agriculture is hereby authorized to use any part of this sum he may deem necessary or expedient, and in such manner as he may think

best, in the collection of information concerning live stock, dairy, and other animal products, and to prevent the spread of pleuro-pneumonia, tuberculosis, sheep scab, and other diseases of animals, and for this purpose to employ as many persons as he may deem necessary.

Acting in accordance with this legislation, the following orders have been made and promulgated by the Secretary of Agriculture:

REGULATIONS PROHIBITING THE TRANSPORTATION OF ANIMALS AFFECTED WITH HOG CHOLERA, TUBERCULOSIS, OR SHEEP SCAB.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., December 13, 1895.

Notice is hereby given that under the law relating to control of contagious and infectious diseases of animals, the regulations of the Bureau of Animal Industry dated April 15, 1887, are hereby amended by additional section, as follows:

SEC. 15. Animals affected with hog cholera, tuberculosis, or sheep scab shall be considered animals affected with contagious or infectious diseases as designated by the law and the regulations of the Bureau of Animal Industry, and shall not enter into interstate trade nor be brought into contact with other animals intended for such trade. Such affected animals shall not be permitted to enter any stock yards or other places where animals are handled for interstate trade, and when so found at such places shall be condemned, tagged, and placed in quarantine by inspectors or employees of said Bureau until proper disposition is made of same.

Stock-yard companies, transportation companies, or others receiving or handling such diseased animals are hereby required to thoroughly disinfect such portions of their premises or property as contained such diseased animals, subject to the approval of the inspectors of said Bureau.

Such diseased animals so quarantined shall not be removed therefrom except by written permit of the inspector in charge. When such diseased animals are found, inspectors shall make careful inquiry as to shipper and owner of same, and transportation company handling same, for the purpose of instituting prosecution under the law provided in such cases.

All animals entering stock yards where inspection exists shall be carefully inspected and those affected with the contagious diseases above mentioned shall be condemned and tagged, and when so condemned shall not be shipped therefrom or enter into the interstate trade; and all violations of this regulation should be immediately reported to the Chief of the Bureau of Animal Industry for institution of prosecution according to law.

J. STERLING MORTON, *Secretary.*

(B. A. I. ORDER No. 5.)

TRANSPORTATION OF SHEEP AFFECTED WITH SCABIES.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., June 18, 1897.

To the Managers and Agents of Railroads and Transportation Companies of the United States, Stockmen, and Others:

In accordance with section 7 of the act of Congress approved May 29, 1884, entitled "An act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases among domestic animals," and of the act of Congress approved April 23, 1897, making appropriation for the Department of Agriculture for the fiscal year ending June 30, 1898, you are hereby notified that the contagious disease known as sheep scab, or scabies of sheep, exists among sheep in the United States, and that it is a violation of the law to receive for

transportation or transport any stock affected with said disease from one State or Territory to another, or from any State into the District of Columbia, or from the District into any State. It is also a violation of the law for any person, company, or corporation to deliver for such transportation to any railroad company, or master or owner of any boat or vessel, any sheep, knowing them to be affected with said disease; and it is also unlawful for any person, company, or corporation to drive on foot or transport in private conveyance from one State or Territory to another, or from any State into the District of Columbia, or from the District into any State, any sheep, knowing them to be affected with said disease. All transportation companies and individuals shipping, driving, or transporting sheep are requested to cooperate with this Department in enforcing the law for preventing the spread of the said disease. Inspectors of the Bureau of Animal Industry are directed to report all violations of this act which come to their attention.

In order to more effectually accomplish the object of the above-mentioned laws, it is hereby ordered that any railroad cars, boats, or other vehicles, which have been used in the transportation of sheep affected with said disease, shall be immediately cleaned and disinfected by the owners or by the transportation companies in whose possession said cars or vehicles may be at the time the animals are unloaded, by first removing all litter and manure which they contain, and then saturating the wood-work with a 5 per cent solution of crude carbolic acid in water. Inspectors of the Bureau of Animal Industry are directed to see that this order is carried into effect.

JAMES WILSON, *Secretary*.

NOTICE OF ENFORCEMENT OF THE LAW.

These orders constitute the notice as to the existence of the disease, and call the attention of transportation companies, stockmen, and others to the provisions of the law. Any one who violates this law or the regulations made in accordance therewith will be subject to the penalty, and can no longer plead ignorance or lack of notice. Owing to an insufficient number of inspectors during the past years, the Department has not been as active in seeking out and prosecuting offenders against this statute as the importance of the matter demands. There have undoubtedly been many shippers, as well as transportation companies, who have rendered themselves liable to prosecution and who have not been proceeded against, but it should not be concluded that, because the penalty has been escaped in a few instances, this immunity will continue. The inspection force is now competent to deal with this subject, and the Department of Agriculture will hereafter take such steps as may be required to stop the dissemination of this contagion through the channels of interstate commerce. In such action the Department will have the assistance and cooperation of all good citizens, and particularly of all of those who are interested in the sheep industry. There is probably no disease in this country, with the exception of hog cholera, which causes greater losses among the domestic animals than does sheep scab, and at the same time none which is so easily, cheaply, and certainly cured. It is, therefore, discreditable to the intelligence and practical qualities of our people that this contagion should still be rampant and continually distributed through the channels of commerce.

All sheep owners who expect to ship or drive their sheep across State

lines should assure themselves before the animals are started that scab does not exist among them. In case symptoms of the disease are discovered, the animals should be dipped and cured before they leave the farm. The information in this bulletin is sufficient to enable anyone to cure this disease with a minimum of trouble and expense. There will hereafter be no excuse for those who claim that they are unacquainted with the nature of the disease or with the methods of treatment.

EFFECT OF MEAT-INSPECTION REGULATIONS.

Sheep suffering from scab are affected by the meat-inspection law and regulations, as well as by those mentioned above. Section 6 of these regulations provides as follows:

6. The inspector in charge of said establishment shall carefully inspect all animals in the pens of said establishment about to be slaughtered, and no animal shall be allowed to pass to the slaughtering room until it has been so inspected. All animals found on either ante-mortem or post-mortem examination to be affected as follows are to be condemned and the carcasses thereof treated as indicated in section 7:

- (1) Hog cholera.
 - (2) Swine plague.
 - (3) Charbon, or anthrax.
 - (4) Rabies.
 - (5) Malignant epizootic catarrh.
 - (6) Pyæmia and septicæmia.
 - (7) Mange, or scab, in advanced stages.
 - (8) Advanced stages of actinomycosis, or lumpy jaw.
 - (9) Inflammation of the lungs, the intestines, or the peritoneum.
 - (10) Texas fever.
 - (11) Extensive or generalized tuberculosis.
 - (12) Animals in an advanced state of pregnancy or which have recently given birth to young.
 - (13) Any disease or injury causing elevation of temperature or affecting the system of the animal to a degree which would make the flesh unfit for human food.
- Any organ or part of a carcass which is badly bruised or affected by tuberculosis, actinomycosis, cancer, abscess, suppurating sore, or tapeworm cysts must be condemned.

Instructions have been issued to inspectors to rigidly enforce these regulations. Sheep in an advanced stage of scab are feverish and unfit for food, and their carcasses will be condemned. Shippers who forward animals for slaughter in this condition will be likely to lose heavily upon them, as they will be subject to quarantine and condemnation. This is an additional and important reason for curing affected animals before they leave the feeding place.

Failure to observe the laws and regulations as they relate to this disease will in many cases result in hardship and loss. In order to avoid such unpleasant results so far as possible and to facilitate the control of the disease this article has been prepared. It is believed that there has been brought together herein all the information needed by the sheep owner to successfully combat this scourge of American flocks.

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BULLETIN NO. 22.

(B. A. I. 120.)

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.

PROCEEDINGS
OF THE
SECOND ANNUAL MEETING
OF THE
ASSOCIATION
OF
EXPERIMENT STATION VETERINARIANS,

HELD AT

OMAHA, NEBRASKA,

September 8, 1898.



WASHINGTON :
GOVERNMENT PRINTING OFFICE.
1898.



LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., November 11, 1898.

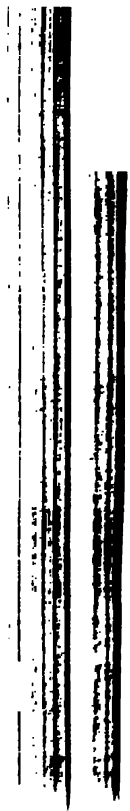
SIR: I transmit herewith a record of the proceedings, with accompanying papers, of the Association of Experiment Station Veterinarians, held at Omaha, Nebr., on September 8, 1898, and recommend its publication as a bulletin of this Bureau.

The Association of Agricultural Colleges and Experiment Stations, the Association of Official Agricultural Chemists, and the entomologists of the experiment stations have been organized for several years, and their proceedings have been published by this Department. That rapid and beneficial progress has been the result of such cooperation is beyond question. The veterinarians recognize this fact, and a few who are especially interested have put forth efforts to effect a similar organization. It is believed that the nucleus already formed will grow into an organization which shall not only be of service to the several States, but be helpful as well to the General Government in cooperating, as necessity may arise, with the Bureau of Animal Industry.

Respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary.



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PROCEEDINGS OF THE SECOND ANNUAL MEETING OF
THE ASSOCIATION OF EXPERIMENT STA-
TION VETERINARIANS, 1898.

The Association of Experiment Station Veterinarians met in its second session in the Millard Hotel, Omaha, Nebr., on September 8, 1898. The following named members were present:

MEMBERS PRESENT.

J. W. Connaway, Missouri Agricultural College Experiment Station, at Columbia.

James Law, Cornell University Agricultural Experiment Station, at Ithaca, N. Y.

C. A. Cary, Agricultural Station of the Agricultural and Mechanical College of Alabama, at Auburn.

S. B. Nelson, Washington Agricultural Experiment Station, at Pullman.

A. T. Peters, Agricultural Experiment Station, at Lincoln, Nebr.

M. H. Reynolds, Agricultural Experiment Station at the University of Minnesota, at St. Anthony Park.

D. E. Salmon, Chief of the Bureau of Animal Industry, United States Department of Agriculture.

M. Stalker, Iowa Agricultural Experiment Station, Ames.

NEW MEMBERS.

New members were elected as follows:

S. S. Buckley, Maryland Agricultural Experiment Station, at College Park.

Paul Fischer, Kansas Agricultural Experiment Station, at Manhattan.

W. C. Langdon, North Dakota Agricultural Experiment Station, at Agricultural College.

F. L. Russell, Maine Agricultural Experiment Station, Orono.

NEW OFFICERS.

Officers for the ensuing year were elected as follows:

President, James Law.

Vice-President, J. W. Connaway.

Secretary-Treasurer, A. T. Peters.

Executive committee: M. Stalker, A. W. Bitting, and M. H. Reynolds.

The Secretary, reporting for the past year, expressed gratification at the work done by the association. There was more cooperation among the stations than heretofore, and good feeling prevailed.

Changes among the veterinarians of the various stations were noted, as follows: N. S. Mayo, who resigned from the Kansas Experiment Station, is now with the station at Storrs, Conn. The position at Storrs was vacated by G. A. Waterman, who is now with the station at Lansing, Mich. A. A. Grange resigned from the Michigan station and is now connected with the Detroit College of Medicine in its veterinary department. The position vacated by S. B. Staples at Baton Rouge, La., is now occupied by W. H. Dalrymple. Paul Fischer is now located with the station at Manhattan, Kans. W. B. Niles resigned from the Iowa Agricultural College, at Ames, and J. A. Craig has been selected as his successor.

Papers read before the association follow herewith.

GROWING TUBERCLE BACILLI FOR TUBERCULIN.

By C. A. CARY, B. S., D. V. M.,

Veterinarian, Agricultural Experiment Station, Auburn, Alabama.

It is not the purpose of this article to project new ideas or discoveries, but rather to make a few suggestions.

In order to make tuberculin one must first secure a pure culture of tubercle bacilli. This may be done by procuring a pure culture from some one who has it, or by isolating the bacilli from a tuberculous animal or man. The latter method should be adopted, because the former leads to lazy habits and inexperience. Secure some fresh tuberculous sputum; wash some of its solid or albuminous particles through six to ten changes of sterilized distilled water; inject one or more of these particles into the peritoneal sac of a guinea pig, a rabbit, or a house mouse. In three or four weeks and before the animal dies of the disease, kill it and from the spleen and liver carefully inoculate several of the ordinary blood serum tubes and of Löffler's blood serum mixture tubes. Keep these tubes in the incubator at 37.5° C., and in twenty to thirty days the characteristic pure-culture growth will be observed in some of the tubes. Other tubes may exhibit no growth, and still others may show growths of other germs.

A large stock of neutral glycerin bouillon should be kept on hand. It is best to make this bouillon from veal or with beef from an animal less than one year old. However, the most essential thing in preparing this bouillon is that it should be neutral in reaction. This is most accurately secured by titrating a 0.4 per cent solution of sodium hydrate into 10 cc. of the bouillon to which has been added a drop of an alcoholic solution of phenolphthalein. The 10 cc. of bouillon

should be taken from the bouillon mixture after it has been heated and the coagulated albuminous materials have been removed by filtration. Then the delicate rose color, which indicates the neutral stage will be readily observed. After making the calculation, neutralize the acidity in the bouillon by adding the proper quantity of an 8 per cent solution of sodium hydrate. After neutralizing, the bouillon should be cooked and filtered again. This method was first used by Schulz, and is described in full by Abbott in his "Principles of Bacteriology."

After the bouillon has been neutralized and sterilized, put it into large, flat-bottomed Erlenmeyer or antitoxine flasks, sterilize again, and then inoculate with tubercle bacilli. Some authorities recommend floating a small quantity of the dry bacilli from an old agar-agar culture upon the surface of the bouillon, but this is very difficult. I find that it is just as efficient to take upon the platinum wire some of a moist growth of the tubercle bacilli and rub them over the inside surface of the flask on a level with the top or upper surface of the bouillon. It is best and easiest to inoculate a small Erlenmeyer flask of bouillon as suggested above; and when a thin film has formed over the surface, small pieces of the film may be lifted out with a hooked platinum wire and they will readily float upon a bouillon surface.

After the cultures have grown at a temperature of 37.5° C. for six or eight weeks, heat in steam sterilizer for 15 minutes; run through sterilized filter paper; then pass it through a Pasteur-Chamberlain air pressure filter or any good filter that will remove all of the germs. The filtrate may be evaporated on a water bath to one-tenth of its original volume, and the result will be the strong, or concentrated, form of tuberculin Kochii. This form keeps better or longer than any other. One-half to 1 per cent of carbolic acid may be added to the filtrate and the tuberculin will keep for some time. It will have the regular strength, and be ready for use without requiring any changes. To the filtrate may be added an equal quantity of pure glycerin; this will preserve it by preventing the growth of accidental infection, but will make it one-half as strong as the normal, or regular, tuberculin. This last method has not been tried sufficiently to warrant the writer in recommending it in preference to the well-tried methods.

FEEDING WILD PLANTS TO SHEEP.

By S. B. NELSON, D. V. M.,

Professor of Veterinary Sciences, Washington Agricultural College and School of Science.

For many years past there have occurred in the State of Washington, when sheep were being moved from winter quarters to summer pastures, serious losses in the flocks. According to the statements of the various sheep owners these losses have occurred in certain definite localities in the spring, but not in the autumn, when the sheep were returned to their winter feeding quarters. These fatalities happening under apparently the same conditions—at the same time and place each year—led the sheep owners to believe that the deaths were due to eating some grass or weed which acted as a poison to the sheep. This condition was brought to the attention of the Experiment Station and certain members commenced the work of investigating the cause of the great mortality in the flocks. As these experiments are not completed, it is not the intention of this paper to discuss the cause of the death of the sheep, but to record the results of feeding to sheep different plants, many of which have been and are considered poisonous to sheep and other domesticated animals.

The station botanist went into these various localities and ascertained what plants were there. About thirty-five different plants were observed, and as many as possible of these were fed and the results noted. The plants found were grouped into two classes. First, those from which might be expected a positive result; second, those from which a negative result might be looked for—judgment on both classes being based on public opinion about many of the plants; and also consideration being given to the abundance with which the plants were distributed. Following is the list of plants collected:

Class 1. *Delphinium nunciesii*, *Castilleja pallescens*, *Crepis barbigera*, *Astragalus dorycnoides*, *Astragalus spaldingii*, *Astragalus palouseensis*, *Zygadenus venenosus*, *Frasera albicaulis*, *Antennaria luzuloides*, *Sisyrinchium grandiflorum*, *Arnica fulgens*.

Class 2. *Saxifraga integrifolia*, *Lupinus ornatus*, *Leptodermis multifida*, *Pencedanum grayii*, *Synthyris rubra*, *Clematis douglassii*, *Heuchera glabella*, *Lithospermum pilosum*, *Geranium*, *Potentilla*, *Eriogonum heracleoides*, *Goum triflorum*, *Grindelia nana*, *Chaenactis douglasii*.

DELPHINIUM MENZIESII.

The first, and which was thought the most important, was *Delphinium menziesii*. Three sheep were used in this experiment. Prior to the experiment they had been kept in a lot where there was running water and were fed timothy hay.

Experiment No. 1.—May 17: At 4:30 p. m., sheep No. 1, a ewe, was tethered in a patch where *Delphinium* was very plentiful. She was returned to the stable at 8:30 p. m. There was evidence that she had eaten the blossoms of a few *Delphinium*. The next day she was placed in the patch at 5 a. m. and returned to the stable at 8 p. m. Besides the plants that she had cropped, there was given to her about 1 pound of gathered *Delphinium* plants, which she ate. On May 19 she was again tethered in the patch and given, in addition to the amount she obtained there, 1 pound of *Delphinium*. This was repeated on May 20; but she had only one-half pound of the gathered plant. She had, however, eaten everything within her reach except some scattered plants of *Brodia douglasii*. The following day she was staked out in a fresh place. She once in a while bit off the heads of the *Delphinium*, but did not seem to prefer it; however, by the evening she had eaten all the green material within the reach of her tether except the *Brodia douglasii*. May 22: She was tethered in a fresh place at 5:30 a. m., and by 9 a. m. she had eaten all the grass and *Delphinium* within her reach. On the 23d and 24th she was all right. Here we have an experiment in which a sheep is kept tethered in a patch of *Delphinium* for six days, and she ate all of the plant that she could obtain and was fed $2\frac{1}{2}$ pounds besides, with a negative result.

Experiment No. 2.—This sheep was placed in a small pen, and on May 18 was given 5 pounds of *Delphinium*, consisting of stems, leaves, flowers, and unripe pods. May 19: He had eaten all that was given him yesterday. May 20: At noon he was given $2\frac{1}{2}$ pounds of *Delphinium* that was gathered on the 18th. Probably considerable of the plant's water had evaporated; how much, I do not know. In $2\frac{1}{2}$ hours he had eaten nearly all of it, and at this time was fed 5 pounds that had just been picked. The next day he had eaten all that had been given him the day before. He was given 3 pounds that was partially dried. It had been picked 24 hours. Four hours later he had eaten the 3 pounds and was then given 7 pounds just gathered. May 22: Removed $1\frac{1}{4}$ pounds that he had not eaten. He was given $3\frac{1}{2}$ pounds 24 hours old. The next day it was all eaten. May 24 and 25: He was well and the experiment was ended.

This sheep was fed, in 5 days, $24\frac{3}{4}$ pounds of *Delphinium*, of which $15\frac{3}{4}$ pounds were freshly gathered, $6\frac{1}{2}$ pounds 24 hours old, and $2\frac{1}{2}$ pounds 48 hours old. All this with a negative result. Certainly

this was more of the plant than a sheep would possibly gather on the range in the same length of time. During these 5 days he had nothing else to eat, subsisting wholly on *Delphinium*.

Experiment No. 3.—This was intended as a check on experiment No. 2; but this sheep did not eat the plant so readily. It consumed during the 5 days only $6\frac{1}{4}$ pounds. The result, however, was also negative.

These experiments certainly are strong evidence that *Delphinium menziesii*, at least when eaten fresh at this time of the year, is not poisonous to sheep.

CASTILLEJA PALLESCENS.

This plant was looked upon with distrust as being poisonous, for the reason that it occurs only in a few places in the State in abundance, and these places were where the sheep often died. Two sheep were used in this experiment, which began May 26. Fed to the first $1\frac{1}{4}$ pounds of Castilleja. The next day it was observed that he had eaten only a little, but he was given, in addition, the same amount as before. May 26: Only a little eaten. May 29: Nearly all eaten. May 30: All was consumed. In 4 days he ate $1\frac{1}{2}$ pounds of the plant. On May 30, the second sheep was fed 2 ounces of Castilleja, which he ate immediately.

The results of both of these experiments were negative.

CREPIS BARBIGERA.

We were informed by a party very much interested in this matter that years ago he had seen *Crepis barbigera* fed to sheep with fatal results. I therefore looked for positive results from these trials. Two sheep were used.

May 26: There were fed to the first one 2 ounces of *Crepis*. The next day he had not eaten all of it. May 28: It was all eaten and he was given one-half pound, which was eaten by the following day. June 23: The second sheep was fed $1\frac{1}{4}$ pounds of *Crepis barbigera*, which he ate as if he relished it.

Nothing detrimental to the sheep resulted from either experiment.

THE ASTRAGALI.

These plants have at various times been suspicioned of causing trouble in our domestic animals. We used the three following species: *Astragalus spaldingii*, *A. palousensis*, *A. dorycnioides*. Of *Astragalus dorycnioides*, $5\frac{1}{2}$ ounces were fed May 26. Of *A. spaldingii*, 12 ounces were fed June 3, and again to the same sheep were given $1\frac{1}{4}$ pounds on June 8, five days later. June 9: $2\frac{1}{2}$ pounds of *A. palousensis* were fed to the third sheep. These sheep

ate the various amounts given them during the night following without any ill effects resulting. Could these experiments have been continued for a longer period of time, it may be that pathological changes would have followed the continuous feeding.

ZYGADENUS VENENOSUS.

This plant is called "poison camas" by the Indians, and it is reported that the eating of the bulb has caused death in the human family. On May 31, June 1 and 2, a sheep was fed $1\frac{1}{2}$ ounces daily. He would eat them from the hand with apparent relish. However, his appetite was kept sharpened so that he would eat almost anything. June 4: Fed to this sheep 1 pound of the plant, both in blossom and in fruit. This amount was all eaten during the night. The sheep remained well.

FRASERA ALBICAULIS.

This beautiful plant was next tried on one sheep. June 3: He was fed $1\frac{1}{2}$ pounds, which he ate before next morning. June 5: Fed to him 5 pounds, of which he ate about one-half during the night. By the 8th he had eaten nearly all. On this day he was fed three-fourths pound more, which was 4 days old. He ate this last amount during the night. In all he received $7\frac{1}{4}$ pounds without any apparent injury.

SISYRINCHIUM GRANDIFLORUM.

The plants of this species that were fed were 4 years old and about 20 of these stalks were fed. The sheep ate them out of the hand. Result, negative.

ANTENARIA LUZULOIDES.

Three pounds were gathered and fed to one sheep. It was all eaten in less than 24 hours, without any visible bad results.

ARNICA FULGENS.

This was the last plant in this class to be used. Fed to a sheep 2 pounds of the plant that had been gathered 18 hours. The material was all eaten during the day. Results, entirely negative.

This closed the experiments with those plants from which we had some reason to obtain some clearly visible physiological effects. There was fed of the different plants from one-eighth to 7 pounds in one day.

In the second class the following were fed and eaten in about 6 hours' time: *Saxifraga integuifolia*, 7 ounces; *Leptotaenia multifida* $1\frac{3}{4}$ pounds; *Grindelia nana*, 2 pounds; *Chaenactis douglassi*, $1\frac{1}{2}$ pounds. No poisonous symptoms followed.

LUPINUS.

On May 30, there was fed to a sheep $1\frac{1}{4}$ pounds at 11 a. m.; at 6 p. m. it was all consumed. The next day he was given $2\frac{1}{2}$ more pounds, which he ate greedily. June 1: That amount was doubled, giving him 5 pounds; this he consumed by the next day. This sheep was fed $8\frac{1}{4}$ pounds in a few hours less than three days. No untoward effects resulted.

PEUCEDANUM GRAYII.

On May 31 I fed $1\frac{1}{2}$ pounds of this stinking plant, having much doubt that the sheep would eat it. The following morning it had, however, all disappeared. Two days later he was fed at one time 4 pounds, which he ate by the following morning. The sheep showed no ill effects from it.

The following five plants were fed to five different sheep: *Clematis douglasii*, 4 pounds; *Lithospermum pilosum*, 4 pounds; Geranium, $3\frac{1}{2}$ pounds; Potentilla, 4 pounds; and *Eriogonum heracleoides*, $3\frac{1}{2}$ pounds. Each sheep ate his allowance in less time than one day and showed no ill effects whatever from it.

Of the next three plants, a smaller amount was given: *Synthyris rubra*, 1 pound; *Heuchera glabella*, $1\frac{1}{2}$ pounds; and *Geum triflorum*, three-fourths pound. The sheep took nearly 24 hours to eat this, and the result again was negative.

In these experiments from three-fourths to 4 pounds of the various plants were fed in one day without appreciable effect on the sheep.

In conclusion, I wish to acknowledge the valuable advice and assistance of the station botanist, C. V. Piper, in carrying on these experiments.

THE EXPERIMENT STATION VETERINARIAN AS A MEMBER OF THE STATE BOARD OF HEALTH.

By M. H. REYNOLDS, D. V. M., M. D.,

Veterinarian, Agricultural Experiment Station of the University of Minnesota.

It is unfortunate that there is not greater uniformity in methods of controlling infectious diseases among domestic animals. Some States have adopted the plan of a State veterinarian, assisted by local deputies, the State veterinarian having little or no connection with the State board of health, while other States are trying to control infectious diseases among domestic animals through boards of live stock commissioners. Some States have a State veterinarian working on very meagre salary, and other States have State veterinarians who are nongraduates and who are given considerable authority. And still other States are trying to control these diseases by means of official titles; that is, they have officers and titles, but these offi-

cers are practically without funds and without sufficient authority.

In Minnesota all police authority concerning infectious diseases of animals is vested in the State board of health. Until January 1, 1897, this board was composed exclusively of physicians. For a great many years Minnesota's State board of health presented the strange combination of a board composed exclusively of practitioners of human medicine, having absolute authority concerning infectious diseases of domestic animals. During this time the gentleman who held the position of Experiment Station veterinarian was expected to visit outbreaks and accomplish marvelous things in the way of checking infectious diseases without any authority. This situation and the results of this method did not prove satisfactory to our stock interests. Stockmen made such vigorous objections during the winter and spring of 1896 and 1897 that the governor decided to appoint a veterinarian to membership on the State board of health. After due consideration he appointed the Experiment Station veterinarian. This is the present situation in our State. Possibly another veterinarian may be appointed to membership on the board in the future, and then the work will be divided more nearly as it should be.

Our newly appointed member of the State board of health was soon made chairman of the committee on infectious diseases of animals and given immediate charge of the correspondence and general office work pertaining to that work. After about six months of this work, he was made director of a newly created veterinary department. This divided the work of the board into three parts—that of the secretary and general executive officer, the bacteriological laboratory in charge of a director (and, by the way, we have a laboratory and bacteriologist in connection with this work in Minnesota, of which we are proud), and the veterinary department. Rules which partly define the duties and authority of the Director of the Veterinary Department have been adopted as follows:

RULES CONCERNING WORK IN THE VETERINARY DEPARTMENT.

1. The Director of the Veterinary Department shall have the privilege of proposing such circulars and rules as he may deem necessary for the purpose of defining the policy of the board with reference to the veterinary work of the board. Such circulars and rules shall be submitted to the executive committee or to the State board of health for approval.

2. The Director shall conduct the correspondence dealing exclusively with veterinary matters. He shall have the necessary police authority to enable him to order quarantine when in his judgment such course shall become necessary. He shall have authority to use his judgment in releasing quarantine in unusual cases, independent of the rules governing quarantine.

3. All agents and employees doing veterinary work in the field shall report to the Director, and it shall be the duty of the Director to furnish the Secretary with such summaries of regular work and with such other information as the Secretary may need.

4. It shall be the duty of the Director to refer such matters as violation of the law dealing with infectious diseases of animals, general enforcement of said law, and indifference and carelessness of local health officers, to the Secretary for action.

5. It shall be the duty of the field veterinarian to investigate outbreaks of infectious diseases among domestic animals, when deemed advisable by the Director of the Veterinary Department, and to attend to such experimental and other veterinary work as may seem necessary. When not doing field work, it shall be his duty to assist the Director in correspondence and other office work.

6. The field veterinarian shall have authority to order quarantine, to kill and release quarantine of domestic animals, in accordance with the rules and recognized methods of the State board of health.

7. It is hereby declared the policy of the State board to pay the salary and furnish transportations for the field veterinarian. Local boards are expected to pay all his other legitimate expenses incurred in work for them.

The work of the Veterinary Department has grown rapidly in all directions. During the last year we employed one field veterinarian. This spring we added another. Thus, you see, we have one veterinarian as a member of the State board of health and two others engaged in the field work of the board. One of these field veterinarians devotes his entire time to hog cholera; the other does miscellaneous work, going to outbreaks of any disease of unusual importance, to outbreaks where there is dispute among different veterinarians who have been called by owners and local boards, and to places in the State where there are no competent veterinarians.

Perhaps I should explain that in Minnesota we expect the local board to employ in ordinary cases a local veterinarian and take care of their own outbreaks of infectious diseases among domestic animals under the direction, of course, of the State board. The law requires that local health officers shall report to the State board of health within 24 hours after receiving information of an infectious disease.

During the four years of my work as an Experiment Station veterinarian before my connection with the State board of health, I was constantly crippled for lack of police authority. An Experiment Station veterinarian is usually expected to visit outbreaks, make diagnoses, and write prescriptions, and then he is severely blamed because the outbreak of glanders or anthrax, or possibly sheep scab, does not promptly abate. During this time I could give such information and advice, and write such prescriptions, but had no authority to insist on anything. If I did this kind of work for the State board of health, the Station received no credit.

On the other hand, the State board of health veterinarian or State veterinarian, as the case may be, who has no connection with an Experiment Station, is very apt to be crippled for lack of opportunities and funds for investigation. For instance, he visits an outbreak

of disease that affords a very peculiar and unusual history. The trouble may be due to faulty conditions of the feed, but he is unable to make a careful investigation and gather satisfactory information as to the cause and nature of the trouble, perhaps for lack of funds for such work.

An Experiment Station veterinarian, who is also a State board of health veterinarian or State veterinarian, has splendid opportunities for collecting material, for doing a great variety of experimental work and keeping accurate records with very little expense to the station. He can collect an abundance of material for almost any sort of experimental work, almost without expense to the station. This is especially true if he has access to a well-furnished bacteriological laboratory.

Another advantage is that such an arrangement brings about a hearty cooperation between two great institutions which might otherwise be working separately and more or less fruitlessly in the same field, each one's work incomplete without the data which the other could furnish. By the way, I might suggest that in Minnesota this plan of cooperation, especially in matters of agricultural interest, is in quite general and happy operation. For instance, our State University, including our Agricultural College and School of Agriculture, our Experiment Station, and State Farmers' Institutes, are all intimately associated in their work, partly because the regents of the University and Experiment Station are influential members on the Board of Control of the State Farmers' Institutes. Our State Fair Grounds adjoin the Experimental Farm; and there is the closest possible cooperation between the State Agricultural Society, Minnesota Stock-Breeders' Association and the Experiment Station with its congeners, the College and School of Agriculture and the State Farmers' Institutes. The Experiment Station veterinarian is also director of the veterinary department of the State board of health.

We find cooperation between the veterinary work of the Experiment Station and the State board of health to be very satisfactory. We found the work unsatisfactory before such combination was made. So long as we had one authority in the State who had charge of infectious diseases, and another who worked in both parts of this field but had no police authority over infectious diseases, the work for each outbreak was more or less tangled.

Owing to the way in which the work is organized in Minnesota, outbreaks of infectious diseases among domestic animals are discovered and reported by the local health officer to the State board. If the outbreak is such that it can be taken care of by the local health officer or by a representative of the State board of health, and all that is needed is a little police authority, it does not necessarily involve the station work at all. On the other hand, if it is work that

invites investigation, the Experiment Station furnishes materials and means for such work, and finally, if it is thought best, publishes and distributes the results of such investigations.

If representatives of the State board of health and Experiment Station go into the legislature together and ask for an appropriation or modification of existing laws, they are apt to be successful.

Correspondence and other office work of the veterinary departments of the two institutions can be greatly economized by cooperation. There is needed only one set of office records and one official head for the two departments. Although there may be a large correspondence and an immense amount of office records and files to look after, the work can be so planned that one office assistant does this work for both. In our State the Experiment Station permits me to use a portion of my time for the State board of health work on the ground that I would have to do a great deal of this work whether connected with the State board of health or not. The office assistant and stenographer does all my correspondence and keeps Station records, although her salary is paid by the State board of health.

By this cooperation we avoid a great deal of duplicating, which would otherwise be unavoidable. For instance, I write a small bulletin on hog cholera and swine plague for the Experiment Station; after it has been distributed by the Experiment Station, I condense it into a small circular for use in the State board of health work.

Let me say, in conclusion, that I hope that the work of this association will aid in bringing about greater uniformity and closer cooperation between our various States; and when this work is organized as it should be every State will have one or more veterinarians on the State board of health, and the Station veterinarian will be ex officio a member of that board.

LABORATORY RECORDS FOR VETERINARIANS.

By A. W. BITTING, D. V. M.,

Veterinarian, Agricultural Experiment Station of Indiana.

One of the first essentials in research work is the adoption of some system of keeping records. It matters little what system is used if it possesses the merit of convenience and clearness in giving the information desired. Some stations have a common method of reporting for all departments. Some utilize blank forms, which are filled out each day and filed. Others keep the records in books of uniform style, while a few have no fixed method, but trust to reporting each experiment by itself.

A method which commends itself to those who have used it is the card-index system, because of its adaptability to so many kinds of reports. It is the only convenient system that can be employed in keeping a bibliography of the special subjects under investigation. It requires but a few hours to catalogue all the articles in the veterinary journals each month and probably only a few minutes to index the special articles relating to the subjects under study. I undertook the task of making a complete index of all the English periodical veterinary literature. The journals indexed are *The Veterinarian*, *The Veterinary Journal*, *The Edinburg Veterinary Review*, *The Veterinary Record*, *The American Veterinary Review*, *The Journal of Comparative Medicine*, *The Veterinary Magazine*, and the *Journal of Veterinary Science in India*. The number of cards now in the index is over 50,000, and it will require about 12,000 more to bring the work up to the close of 1898. While this index is of great convenience and value, I could not recommend anyone to attempt to duplicate it, as the work is several times greater than is anticipated. If a few stations need such an index, it would be far more convenient to have a printed copy made from this one than to duplicate the work. I believe, in general, it will be found to be profitable to index only special subjects, although all will admit the use and desirability of having a complete index. In making a bibliographical index the same style should be used as followed by public libraries.

The card index is the most convenient form of recording the presence and distribution of diseases in the State. The card should give the name of the disease, the locality, the time when reported, and the name of the person reporting it. The cards may be filed according to the disease reported or by counties to give the distribution.

The index is one of the best means for keeping a record of the equipment of the laboratory. The card should give the name of the article, of whom and when purchased, and the cost. When the article is broken or consumed the card may be removed and an inventory is always at hand. For recording staining reagents it should give the formula and date of preparation of each.

A card index serves as a convenient method of keeping certain laboratory notes. Examinations are frequently made of material out of the usual line of work and a brief record is all that is needed. Such a record upon a card may be filed and become useful at some future date when the subject is under consideration. Reports of cases may be filed in the same way. So far as possible it is best to use the large index cards, and for recording laboratory examinations or cases cards of usual height but double length.

THE DESIRABILITY OF COOPERATION BETWEEN THE STATION VETERINARIAN AND THE LOCAL VETERINARIANS IN THE STATE.

By A. W. BITTING, D. V. M.,

Veterinarian, Agricultural Experiment Station of Indiana.

It may be possible to imagine an experiment station so well equipped and so liberally provided with funds that the veterinarian at the head of his department can use his discretion in the selection of the disease or the special problem for investigation; that he may go wherever the disease is present, stay as long as may be necessary to make a complete series of observations, or repeat his visitations until he has learned all that he can. In such a position he could be independent of public demands, and could utilize all his energy in prosecuting his work.

A veterinarian occupying a position in a State experiment station is confronted with a difficult set of conditions. The funds for maintaining this department are limited. He is usually compelled to make his studies upon outbreaks of disease and such sporadic cases as occur in the immediate vicinity of the station. If he visits localities at some distance from the station he is rarely permitted to have all the time that is necessary to complete the work or repeat his visitations because of exhaustion of the funds. Under the conditions existing at most of the stations the veterinarian can have at best only a small number of cases of any disease upon which to make observations or experiments. The public demands that he should be informed concerning the occurrence and distribution of contagious diseases, and in many instances that he shall give assistance in their suppression. Of all the members of the station staff he is the least independent. He can not order an outbreak of disease for his special study; he can not control the location or duration of the disease when one does occur; and he can obtain information upon the occurrence and distribution of contagious diseases in the State only through correspondence.

I believe the veterinary department of the experiment station and the veterinarians in the State should be on such friendly terms that cooperative work may be conducted to the advantage of both. The station can act as a medium to give the latest information upon the results of its own researches and announce the work that is being accomplished at other places. The station may also give assistance in diagnosis in certain cases where the microscope or other special equipment is necessary. The veterinarian, in turn, may be of great assistance to the station by reporting outbreaks of disease and the results of any experiments which he may undertake.

In 1896 and 1897 I made an attempt to determine whether cooperation was practical and whether the station would gain information to compensate for the work required. There were ninety-six qualified veterinarians in the State. A circular letter setting forth the plans and blanks for reporting the number of cases occurring in their practice each month were sent to each veterinarian. The list of diseases upon which reports were desired were those most common in the State. It included abortion (infectious) among mares and cows, actinomycosis, anthrax, cholera, glanders, influenza, rabies, specific ophthalmia among cattle, sporadic aphthæ, tetanus, tuberculosis, azoturia, colic, other intestinal diseases, parturient apoplexy, periodic ophthalmia, pneumonia, cerebro-spinal meningitis, bursatte, fistulæ, lameness, etc. At first I received about thirty-five replies, but the number gradually became smaller until only eight remained after the month of August. In 1897 I tried a different plan, and made my blank upon a postal card and distributed them at the end of each month. I sent the postal cards to about twenty-five addresses and had fifteen reports for each month of the year. At the close of the year there was much greater interest than at the beginning, and I feel certain that I could have doubled the number of correspondents. The work was abandoned, as I contemplated withdrawing from station work.

The time covered by this work is admittedly too short to draw conclusions from the reports, but they seem to indicate that certain diseases, such as tetanus and parturient apoplexy, are of far more common occurrence than is generally suspected; that certain diseases, such as fistulæ and bursatte, are common in some localities and rare in others; and that seasonal influences are less marked than is often asserted. The station received fifty-one species of parasites for identification and also a number of pathological specimens. At the suggestion of the writer several new preparations were used and reports received. The station supplied its own publications and gave notice of all bulletins upon veterinary science as they appeared at other stations and the Bureau of Animal Industry. Upon the whole the station was well repaid for its part of the work, and the veterinarians expressed the desire to have it continued.

One of the good effects that was wholly foreign to the original object was the increased interest which it developed in the State Veterinary Medical Society. At the first three meetings of the society which I attended, only seven or eight members were present. The three meetings held after the correspondence was established was attended by from twenty to thirty members.

THE EXHIBIT OF THE UNITED STATES EXPERIMENT STATION VETERINARIANS AT THE PARIS EXPOSITION IN 1900.

By A. T. PETERS, D. V. M.,

Investigator of Animal Diseases, Agricultural Experiment Station of Nebraska.

I take pleasure in presenting a subject which ought to be of vital interest to every member of this association, namely, the veterinary exhibit of the United States Experiment Stations at the Paris Exposition in 1900. As is well known, at the convention of the Association of Agricultural Colleges and Experiment Stations, held in July, 1897, at Minneapolis, a committee upon a collective exhibit of the experiment stations at the Paris Exposition in 1900 was appointed, consisting of H. P. Armsby, M. A. Scovell, W. H. Jordan, A. W. Harris, and A. C. True. The committee has had a meeting in conference with Hon. James Wilson, Secretary of Agriculture, and the executive committee of the above association. As yet no appropriation has been made by Congress for such an exhibit, but the committee, as a result of their meeting, have seen fit to proceed with the preliminary arrangements. Mr. Armsby has written me regarding the exhibit of the Veterinary Department, and I have consented to bring the matter before this body for its careful consideration.

Mr. Armsby writes that "the committee desires to make in this exhibit a presentation of the origin, history, and work of the stations which shall be calculated to illustrate the essential and distinguishing features of the American system of experiment stations as compared with those of other countries. With this end in view, it is proposed to make the exhibit technical rather than popular in its nature, appealing to the expert and the administrator rather than to the farmer. In carrying out this plan, it is the intention to make use of two methods: First, it is intended to prepare a report which shall include a characterization of the work of the experiment stations along four main lines, namely: (a) Police and control work; (b) studies of natural resources and conditions; (c) demonstration on experiments; (d) scientific investigations. Second, based upon this report, it is desired also to make as attractive an exhibit as practicable of selected typical examples of experimental methods and results."

I have given this matter no little study, and the more thought I spend upon it the more perplexing becomes the question as to how we veterinarians can best show to the Old Country our unique way of investigating scientific problems. I believe this question can be settled right here at the meeting of experiment station veterinarians. And hence I have thought it advisable to offer this paper merely as an introduction to the discussion which I know you will enter into

heartily. The committee desires not "a complete and exhaustive report upon our work, nor a complete bibliography, but a characterization of the main lines and tendencies of our work, classified under the headings given above."

Concerning police and control work may be mentioned the work done by the experiment station veterinarians in aiding the Bureau of Animal Industry in formulating the best methods of controlling contagious diseases by quarantine regulations, sanitary measures, and vaccination. In this work what greater triumph have our foreign brethren scored than we have scored in preventing the spread of Texas fever to the Northern States by the quarantine laws, and in successfully eradicating pleuro-pneumonia in the United States; which latter fact will always be a source of great wonderment to foreign veterinarians, and which it will take scores of years for them to accomplish? Too much can not be said in regard to our work in eradicating sheep scab by the enforcement of sanitary measures and quarantine rules, when we consider how easy it is for it to spread unless the strictest laws are observed. Another thing that is characteristic of American veterinarians is the work done by the different States in controlling tuberculosis and glanders by the extensive use of tuberculin and mallein and the destruction of the diseased animals.

In demonstrating our experiments we shall be able to show that they are original and unique. Though not all have been successful, yet it must be admitted that a great per cent have been successful; in fact, a much larger per cent than is publicly known. And even those that have failed have in a way been stepping stones to higher scientific investigations. The veterinarians abroad who are unfamiliar with what we have done, and who have given us credit for so little, can, if we take advantage of this opportunity, be shown that our work ranks as high as theirs. This latter fact has never been conceded by them, but we must remember that the investigations and experiments of our veterinarians do not date back so far as do those of European investigators, and hence it becomes our opportunity to illustrate to them that our work of recent years compares surprisingly favorable with theirs. Personally, I believe that along certain lines our investigations even exceed those of our foreign brethren. To back this up I should like to call attention to American investigations in Texas fever as compared with the German investigations in Wildseuche and Büffelseuche, which are supposed to be the same as Texas fever.

Besides these researches, which have resulted in the discovery of the real cause of Texas fever, the movements of the little tick, and the best method of treatment and prevention, let me call attention to the work of the Bureau of Animal Industry and the experiment

stations in investigating hog cholera. In this country this investigation is undoubtedly foremost. As much as this may be said concerning actinomycosis and many other diseases too numerous to mention here.

I have pointed out to you only a few of the many distinguishing features that go toward characterizing the work of the United States experiment station veterinarians, and I am therefore in hopes that these few words of introduction will aid in bringing out from the members statements of just how and what we ought to exhibit before our foreign veterinarians.

The idea of the committee is to demonstrate in the report the characteristic investigations along the lines of the various diseases for which each station is noted. This should be prepared in a technical, concise manner, yet simple and practical enough to prove that no nation on earth has done more along these lines in recent years than has the United States agricultural experiment stations. For instance, this report should contain an outline of the work done, together with the results in the separate States, including police and control work, and laboratory and field investigations and experiments. The exhibit accompanying said report should consist of apparatus, specimens, statistics, and all materials used, thus making the report more practical and illustrative than otherwise.

To make such a showing possible, and in order to do justice to the United States experiment stations, it will require your entire cooperation in the matter; and allow me, in closing, to express the hope that you will each and every one enter heartily in assisting the committee to gather the material necessary to make the venture a success.

THE VALUE TO VETERINARIANS OF COOPERATIVE EXPERIMENTS.

By L. L. LEWIS, M. S., D. V. M.,

Veterinarian, Oklahoma Agricultural Station.

As new as the Association of Experiment Station Veterinarians is, the subject of cooperative experiments is still newer so far as the station veterinarian is concerned. It is not to be expected that with so recent an organization there should be any definite understanding in regard to cooperative work, but to my mind there is no one thing more necessary to the advancement of the veterinarian's work than an organization of those interested in experimental work. Cooperative experiments will follow as a natural consequence of such an organization, but it is not the intention or province of this paper to favor any one plan of work, but rather to try to mention some of its advantages, hoping that sufficient interest will be taken in the subject to bring it before the next meeting in the form of a suitable discussion.

The station veterinarian's work is almost the only line of station work that is not to a certain extent cooperating with other stations for the purpose of securing more complete data on certain lines of work. The other departments of the station are getting better results by cooperative work, not only with other experiment stations, but also with the Department of Agriculture. The veterinarian should not be less ready to exchange views and ideas with his fellow worker than men engaged in other lines of work, and the more liberal is this exchange the surer of success.

I think there is no work better suited to such organization than the work of the veterinarian. The pathology and therapeutics of most of the contagious and infectious diseases can be as successfully studied in one part of the country as another, and by an exchange of data on the work, following a general plan or outline, some definite results will be secured in very much less time than by the present method where everyone works independently, repeating the mistakes of others and duplicating, it may be, a large amount of work. More data of a reliable nature could be secured in one year on any given subject by the cooperation of several stations than are now available in from two to five years.

It is not probable that very many of the stations will do very much work of this character in the immediate future. There has been some work of this character in the past two years and, so far as the writer knows, it is a satisfactory method of conducting experiments.

Where assistance can be given without interfering with the general plan of work it should be done if such a proposition be made. But the idea of cooperative work should not mean the sacrificing of one's ideas of method and manner of work; if it did, it certainly would be a failure.

A portion of the station veterinarian's time is occupied by teaching, as most of them are members of the teaching staff in the agricultural colleges. A large part of his time may be occupied by work conducted in the laboratory or routine in character, but aside from this work there is time to devote to field experiments or to laboratory work of a cooperative character.

I realize that a more able writer and a more experienced station worker should have been assigned to this duty, but I trust that by the time the next meeting is held there may be more stations interested in the work, as I believe that cooperation will increase the usefulness of the veterinarian's work in a scientific as well as a practical way.

HISTORY OF THE ASSOCIATION.

The Association of Experiment Station Veterinarians is an outgrowth from the correspondence that sprung up in 1896 among various Experiment Station veterinarians who saw the necessity of such an organization. As a result of this correspondence, circular letters were sent out to all veterinarians of the United States Experiment Stations and Agricultural Colleges asking them as to the advisability of such a movement, and informing them that an attempt would be made to organize temporarily at the Buffalo meeting of the United States Veterinary Medical Association. In February, 1897, another circular letter was addressed to the same men stating that a temporary organization had been formed, in accordance with the plans, by Doctors Salmon, Stalker, Reynolds, Grange, Cary, Williams, Pearson, and Peters. It was the unanimous opinion of these gentlemen that an association of this character would be of great benefit to the station veterinarian. Accordingly, at the Nashville meeting of the United States Veterinary Medical Association in 1897, a permanent organization was effected, papers were read, permanent officers were elected, and a constitution and by-laws adopted.

The second annual meeting, the proceedings of which are herewith published, was held at Omaha with the United States Veterinary Medical Association on September 8, 1898.

CONSTITUTION AND BY-LAWS OF THE ASSOCIATION OF EXPERIMENT STATION VETERINARIANS.

CONSTITUTION.

ARTICLE I.—NAME.

This Association shall be known as the Association of Experiment Station Veterinarians.

ARTICLE II.—OBJECT.

The object of this Association is to bring the several veterinarians of the different Experiment Stations in a closer communication, to advance their common interests by the establishment of honorable and fraternal relations, and to secure the benefits of cooperation and united action in bringing into prominence the merits of scientific veterinary investigation.

ARTICLE III.—MEMBERS.

All those who are connected with the U. S. Experiment Stations and Agricultural and Mechanical Art Colleges may, upon application and the payment of the initiatory fee, become members of this Association.

ARTICLE IV.—OFFICERS.

Chapter 1. The officers of this Association shall consist of a President, Vice-President, Secretary-Treasurer, and three Trustees, who shall constitute the Executive Committee.

Chapter 2. The officers shall be elected for one year by ballot and hold office until their successors are elected.

ARTICLE V.—THE EXECUTIVE COMMITTEE.

The Executive Committee shall manage the business of the Association under such regulations and restrictions as the Association may from time to time prescribe.

BY-LAWS.

SECTION I.

Article 1. The President shall preside over the meetings of the Association.

Article 2. He shall deliver an address at the annual meeting succeeding his election.

Article 3. He shall appoint all committees not otherwise provided for.

SECTION II.

Article 1. The Secretary shall give due notice of the time and place of each annual meeting. He shall conduct all correspondence of the Association, retain copies, and report the same at each meeting.

Article 2. The Secretary shall also perform such other duties as may be imposed upon him by the Association.

SECTION III.

Article 1. The Secretary-Treasurer shall collect all bills due the Association and give security for all moneys held by him if desired. He shall keep a correct account of the same, holding receipts for all disbursements. He shall furnish a statement of the funds of the Association at each annual meeting, or oftener if desired.

Article 2. He shall be the custodian of all moneys belonging to the Association, or donations, and keep a correct account of the same with the names of the donors, and report such members as have failed to pay their dues for one year.

Article 3. The Treasurer shall pay out no money from the treasury, or dispose of any money or property of the Association, without the knowledge and approval of the President. All bills audited by the Finance Committee shall be paid by the Treasurer upon the order of the President.

SECTION IV.

Article 1. Order of business:

Roll call.

Reading of minutes of previous meeting.

President's address.

Reports of committees.

Admission of new members.

Unfinished business.

New business.

Election of officers.

Miscellaneous business.

Papers and discussions.

SECTION V.

Article 1. Seven members shall constitute a quorum for the transaction of business at the annual meeting.

SECTION VI.

Article 1. The annual dues shall be one dollar (\$1.00) and the secretary is instructed to levy a tax upon the members sufficient to cover any deficit that may occur.

SECTION VII.

Article 1. Any proposed alterations or amendments to the constitution or by-laws shall be submitted in writing to each member of the Association at least three months before the next annual meeting.

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BULLETIN No. 23.

(B. A. I. 117.)

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.

THE SERUM TREATMENT OF SWINE PLAGUE
AND HOG CHOLERA.

BY

E. A. de SCHWEINITZ, Ph. D., M. D.,
Chief of Biochemic Division,

WITH THE COLLABORATION OF MARION DORSET, M. D.,

UNDER THE SUPERVISION OF

D. E. SALMON, D. V. M.,
Chief of the Bureau.



WASHINGTON :
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1899.



LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., December 24, 1898.

SIR: Laboratory investigations in the use of serum for treating hog cholera and swine plague have been carried on by this Bureau for several years, and with such favorable results that, upon your direction, the treatment was given an enlarged field in Page County, Iowa. The work conducted there during the season of 1897 showed that the treatment saved about 80 per cent of the animals injected. The results in 1898 have been exceedingly satisfactory and tend to confirm those of the previous year. So much interest has been manifested in this work that this article on the subject of serum treatment for hog cholera and swine plague has been prepared by Dr. de Schweinitz, who has been in charge of the work, assisted by Dr. Marion Dorset, and others, and its publication as a bulletin of this Bureau is recommended.

The public should be informed that the preparation of the serum by the Bureau is necessarily limited, and therefore its distribution is confined to inspectors for the Bureau and to experiment stations.

Respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary.

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THE SERUM TREATMENT FOR SWINE PLAGUE AND HOG CHOLERA.

By E. A. DE SCHWEINITZ, Ph. D., M. D.,
Chief of Biochemic Division.

One of the most interesting and difficult problems which has engaged the attention of this Bureau for some years has been the discovery of a method or methods for the prevention or cure of diseases known as *hog cholera* and *swine plague* among swine.

PRELIMINARY EXPERIMENTS.

In the year 1890 a study of the substances secreted by the hog cholera and swine plague germs was begun in the Biochemic Laboratory of the Bureau of Animal Industry by the writer of this article. From cultures of these bacteria he succeeded in isolating two substances albuminoid in character and others belonging to the group called amines, which produced, when injected into experimental animals, some of the characteristic symptoms of hog cholera or swine plague, respectively, and conferred upon these animals an immunity to subcutaneous inoculation with hog cholera and swine plague germs, respectively. The reports of this work were published in the Medical News of Philadelphia in September and October, 1890, and annual reports of this Department for 1890 and 1891.

A series of practical experiments was then carried on at the experiment station of the Bureau upon swine. The animals were injected with the products of the growth of these bacteria, including the contents of the cells themselves, as well as those products of excretion of the cells which were in solution in the culture liquid. In ten days after inoculation they were exposed to hog cholera and swine plague, respectively, by an intravenous inoculation with a virulent germ sufficient in quantity to kill the check animals in a week to ten days. In general these results were fairly satisfactory, in so far that, while the check animals died, about 50 per cent of the treated animals remained alive. The method of exposure, however, was unsatisfactory, as it was not always possible to be certain that the checks would die, and in a good many cases the exposure of the treated animals by this method of inoculation was very much more severe than that which they would in all probability have been subjected to in the field. In addition, the injection of these products of the bacilli produced disagreeable local lesions in the animals.

While the results of the work showed that considerable immunity to these diseases could be secured by this method of treatment, it did not appear practicable for field work, and consequently other laboratory investigations were begun.

A more thorough study of the substances produced by the hog cholera germs, the results of which were published in the Philadelphia Medical News of October, 1892, showed that if the cultures of this germ were made upon milk or other suitable media, it was possible to obtain from these cultures a small quantity of enzymes, or soluble ferments. These ferments secreted by the hog cholera bacillus were also tried for the purpose of producing immunity in experimental animals, with satisfactory results. The injection of quantities of these ferments below 0.01 of a gram was without ill effect. If the amount injected was increased beyond this point there was a rise of temperature in the animals for several days, and in several instances 0.05 of a gram was sufficient to kill the animals. A single injection of guinea-pigs with 0.04 of a gram of the ferments served to make the animals immune to an inoculation with the hog cholera germ that was sufficient to cause the death of the checks in ten days. In the article referred to the opinion was expressed that the soluble ferments exert a very potent action in rendering animals insusceptible to disease, and that to the indirect action of the specific ferments secreted by the hog cholera and other germs the protective and curative influence of blood serum from immune animals may be traced, as well as the immunity produced by injecting animals with cell contents or the products of the cell growth. At about that time the writer published an article in the Philadelphia Medical News, September 24, 1892, upon the production of immunity in guinea-pigs to hog cholera by the use of blood serum from other guinea-pigs that had been previously immunized. The guinea-pigs used as a source for the blood serum were immunized by means of the cell contents and products of the growth of hog cholera bacilli, and after they had withstood an inoculation of the germ of sufficient virulence to cause the death of the checks they served as a source of serum to be used for injecting other healthy guinea-pigs or for treating guinea-pigs infected with hog cholera. The results of these experiments were also satisfactory, but for various reasons they could not be pushed as rapidly as desired. The experiments were continued, however, in a quiet way, and the use of the products of other bacteria allied to the hog cholera germ, as the *Coli communis*, etc., were tried. The results were satisfactory for the purpose of securing immunity to hog cholera. As stated in one of the papers mentioned, it is probable that all gas-producing bacilli secrete a soluble ferment, and that this ferment is of considerable importance in connection with the production of immunity. While it is not probable that each germ gives rise to a distinctive ferment, it is probable that different germs secrete two or more ferments, and that the combined action of these ferments is necessary for securing satisfactory results in immunity.

RESULTS OF EXPERIMENTS WITH SERUM AS A CURATIVE AGENT.

During the years 1893, 1894, and 1895 it was possible to make some more experiments with the serum as a curative agent for hog cholera and swine plague upon a somewhat larger scale. These experiments were reported to the Society for the Promotion of Agricultural Science in Buffalo, N. Y., in August, 1896, and published in their proceedings, in the New York Medical Journal, September 5, 1896, and in Centralbl. f. bakt. u. Parasit., Vol. XX, No. 16-17, 1896.

The animals used for the production of the serum were treated for me by Dr. Schroeder, in charge of the experiment station of the Bureau.

After several months' injection of the cows with the virulent hog cholera culture, the serum was tested. The following is a record of one of the experiments:

Guinea-pigs injected with serum from treated cows.

March 9, 1894, No. 219, weight 17 ozs., received 1.5 c. c. of serum.
 March 9, 1894, No. 220, weight 12 ozs., received 1.5 c. c. of serum.
 March 9, 1894, No. 221, weight 11 ozs., received 1.5 c. c. of serum.
 March 9, 1894, No. 222, weight 17 ozs., received 1.5 c. c. of serum.
 March 18, 1894, No. 219, weight 18 ozs., received 3 c. c. of serum.
 March 18, 1894, No. 220, weight 11 ozs., received 3 c. c. of serum.
 March 18, 1894, No. 222, weight 19 ozs., received 3 c. c. of serum.
 March 18, 1894, No. 223, weight 14 ozs., received 3 c. c. of serum.

No. 221 was found dead from pneumonia on March 16.

On March 20 No. 220 was found dead from pneumonia.

March 23, 1894, No. 219, weight 17 ozs., received 1.5 c. c. of serum.
 March 23, 1894, No. 222, weight 17 ozs., received 3 c. c. of serum.
 March 23, 1894, No. 242, weight 10½ ozs., received 3 c. c. of serum.
 March 23, 1894, No. 243, weight 10½ ozs., received 3 c. c. of serum.
 March 23, 1894, No. 246, weight 9½ ozs., received 3 c. c. of serum.
 March 28, 1894, No. 219, weight 18 ozs., received 4.5 c. c. of serum.
 March 28, 1894, No. 222, weight 18 ozs., received 6 c. c. of serum.
 March 28, 1894, No. 223, weight 13 ozs., received 4 c. c. of serum.
 March 28, 1894, No. 242, weight 12 ozs., received 3 c. c. of serum.
 March 28, 1894, No. 243, weight 12 ozs., received 3 c. c. of serum.
 March 28, 1894, No. 246, weight 11 ozs., received 3 c. c. of serum.

On April 9 the following guinea-pigs were inoculated with one-tenth cubic centimeter of peptonized beef-broth hog cholera culture each:

No. 219, weight 23 ozs.	No. 261, weight 12 ozs.
No. 222, weight 18 ozs.	No. 262, weight 15 ozs.
No. 223, weight 12 ozs.	No. 263, weight 20 ozs.
No. 242, weight 13 ozs.	No. 264, weight 14 ozs.
No. 243, weight 13 ozs.	No. 241, weight 15 ozs. (check).
No. 246, weight 12 ozs.	No. 260, weight 12 ozs. (check).

Nos. 261, 262, 263, and 264 had not received previous injections with serum; 241 and 260 were checks; while the other animals had been treated with serum, as above noted.

April 11, No. 261 received 3 c. c. of serum.

April 11, No. 262 received 3 c. c. of serum.

April 11, No. 263 received 5 c. c. of serum.

April 11, No. 264 received 4.5 c. c. of serum.

April 14, No. 261 received 3 c. c. of serum.

April 14, No. 262 received 3 c. c. of serum.

April 14, No. 263 received 4.5 c. c. of serum.

The results: April 17, No. 260 (check) was found dead from hog cholera; April 19, No. 222 was found dead from hog cholera; April 20, No. 264 was found dead from hog cholera; April 25, No. 241 (check) was found dead from hog cholera; Nos. 219, 223, and 261 were also found dead from pneumonia. There had been quite an outbreak of pneumonia among the guinea-pigs just at this time, accounting for these lesions which were not due to cholera.

Of the entire number of pigs treated, therefore, the checks died in from 8 to 16 days. Three of the pigs that had previously been vaccinated with 6 c. c. of serum each recovered and two of the pigs that had received 6 and 8 c. c. of serum two days after the inoculation with the germ recovered from the disease. These experiments repeated later showed that while the blood contained a curative and protective substance the quantity present at the time would not cure disease by the injection of several small doses. Subsequently, by continued treatment of the animals, the curative material was increased in quantity, as will be seen from experiments reported later.

Already in 1894 some work had been done which served to emphasize the close relationship between the products in artificial media of the growth of the hog cholera germ and those produced by the growth of the bacillus *Coli communis* (the ordinary intestinal bacillus). A pig which had been immunized to hog cholera by long-continued injections of the *Coli communis* and subsequently inoculated with the hog cholera germs was used as a source for the serum for treating guinea-pigs, as follows:

No. 425, weight 11 ozs., received 3 c. c. of serum.

No. 426, weight 9 ozs., received 4.5 c. c. of serum.

No. 422, weight 9 ozs., received 0.5 c. c. of serum.

No. 423, weight 11 ozs., received 1.5 c. c. of serum.

No. 424, weight 8 ozs., received 2 c. c. of serum.

Fifteen days afterward these pigs and two checks, Nos. 442 and 443, were inoculated with one-tenth cubic centimeter of a peptonized beef-broth hog cholera culture one day old. Seven and 10 days,

respectively, after this inoculation the checks were found dead from hog cholera while the other guinea-pigs remained well. These experiments repeated upon another set of animals gave about the same results, which showed that an immunizing substance is produced in the blood of a hog that is protected against the cholera. Another set of experiments, the details of which need not be reported here, showed that while the hog itself might be immune to disease, its blood serum may have lost the power of conferring immunity upon other animals. This confirms the conclusion with reference to the use of blood serum in other diseases, namely, that the immunizing principle in the blood serum can best be obtained if the animals are inoculated from time to time with the culture, or toxins. So long as the animal receives continued injection of the cell contents or products of the germ the immunity of that particular animal continues, and in addition the antitoxic substance is found in the blood. After some time the antitoxic substance may no longer be noted in the blood, or only in small amounts, while the immunity of the individual animal from which this blood is obtained may still continue. The antitoxic substances are apparently the products of cell activity only.

These experiments with the serum of immune hogs and the serum of cattle and horses that had been made artificially immune warranted further investigation.

In practice, however, it is found that hogs are exposed not only to the disease of hog cholera but also to another disease called swine plague, both of which may occur together in the same animal, or there may be an outbreak of one or the other disease alone. As the experiments made in 1891 with the products of the swine plague germ as obtained from artificial media had shown that these could be used as immunizing agents it was very reasonable to suppose, when the nature of the disease swine plague is considered, that an antitoxic¹ serum for this disease might also be obtained. A cow was used as the source of the serum after she had been repeatedly inoculated with cultures of the swine plague germ. The preliminary tests of this serum were made upon rabbits. One-tenth cubic centimeter of a peptonized beef-broth culture of the swine plague sufficient to kill a rabbit in fifteen to eighteen hours was used. Several sets of experiments showed that while the check rabbits were killed within the specified time by the swine plague cultures, others could be kept alive from six to ten days longer than the checks by the injection of 9 c. c. of the serum per pound weight. As these results indicated that antitoxic, or curative, substances were present in the serum, its

¹ The word antitoxic is used in this article in the sense of curative.

effect was tried upon guinea-pigs. One-tenth cubic centimeter of swine plague culture was used, sufficient to kill the animals. The experiments gave the following:

- No. 348 (check), weight 12 ozs., received 0.1 c. c. swine plague culture.
 No. 349, weight 8 ozs., received 0.1 c. c. swine plague culture and 3 c. c. serum.
 No. 350 (check), weight 11 ozs., received 0.1 c. c. swine plague culture.
 No. 351, weight 9 ozs., received 0.1 c. c. swine plague culture and 6 c. c. serum.
 No. 352, weight 8 ozs., received 0.1 c. c. swine plague culture and 6 c. c. serum.

While the check animal died the pigs which received the antitoxic serum recovered, about 6 c. c. per pound weight being required to check the disease.

With the assistance of Dr. Dorset I next endeavored to isolate the antitoxic principle contained in the serum, according to a method prescribed by Brieger and Boer¹ for the isolation of diphtheria antitoxin, by the use of zinc sulphate, repeated solution in sodium hydrate and precipitation with CO₂. In this way from 90 c. c. of serum about 0.152 gram of a practically ash-free white powder was obtained. The antitoxic properties of this substance when tested proved to be about the same as those of the serum. As we had therefore a serum which exhibited antitoxic, or curative, properties for hog cholera, and another which exhibited antitoxic, or curative, properties for swine plague, it was of interest to see if these serums would be of use interchangeably. The result showed, however, that the hog cholera serum protected guinea-pigs from the cholera germ but not from the swine plague germ, and that the swine plague serum protected or cured guinea-pigs from infection with the swine plague germ but not from the hog cholera germ. This demonstrated again the independent character of these two diseases, attention to which has often been drawn in previously published work.

As the preliminary experiments so far reported had shown that specific antitoxic serums for hog cholera and swine plague could be obtained, the work was carried forward on a somewhat larger scale, and serums secured which were effective in much smaller doses upon experimental animals. The laboratory results seemed to warrant a trial of this method in the field, and experiments were made during the summer and fall of 1897 on this line in Page County, Iowa.

THE PREPARATION OF THE SERUM.

In preparing the serum for this work we have used cattle, horses, mules, donkeys, etc.; the animals received injections of the filtered, sterile, or live cultures of the hog cholera germ and swine plague germ, respectively, or the solutions of their products, including cell contents, extracts, and secretions. These injections were made

¹Zeit. für Hyg. u. Infectiouskrank., Bd. XXI, Pt. 2.

either subcutaneously, intravenously, or intra-abdominally, or a combination of two or more of these methods, depending upon the results obtained. The quantities given at first were small, but increased gradually until large amounts of the material used could be injected without bad results. This treatment of the animals must be carried out very carefully and requires six to eight months' time before the serum is sufficiently potent to be of any practical use. As the treatment continues the power of the serum to check the motility of the hog cholera germ increases with rapidity. The serum of animals treated with swine plague cultures also sometimes checks the motility of the hog cholera germ. The value of the serum was determined by the amount of serum necessary to protect or cure guinea-pigs from an inoculation with the hog cholera germ or swine plague germ sufficiently virulent to kill the check animals in the usual time—a week to ten days.

The details of the method of treating these animals for preparing the serum, which were the results of numerous conferences between Dr. Schroeder, in charge of the experiment station, and the writer, will be given in another publication. Too much care can not be observed in selecting the animals and in observing proper precautions during the injections with the different products of the cultures that are used for producing in the animals a curative serum. The testing of the serum, as already noted, was usually made by treating animals that had been previously inoculated with a fatal dose of the culture. This method of testing is sometimes not altogether satisfactory so far as the cholera germ is concerned, although the results given with the swine plague are quite satisfactory. We have therefore used another method, namely, the injection of a quantity of the products of the hog cholera germ sufficient in quantity to kill the check guinea-pigs, while the other guinea-pigs so injected and treated with the serum will not succumb. This method promises more satisfactory results, and a better basis can thus be secured for estimating the amount of curative serum which should be used for injecting large animals.

In order to keep and utilize large quantities of serum, we have found it very convenient to concentrate it, and by making use of well-known principles we have accomplished this by freezing, so that a more concentrated material can be obtained and a less quantity of serum used for injecting animals. The preparation of a solid serum or an extract from the serum of the active products, secured by means of precipitation, has already been referred to, but for practical purposes it would appear that a concentrated serum is the best product to place in the hands of the individual veterinarian. If our experiments, continued on a still larger scale, give as satisfactory results as those obtained during the years 1897 and 1898 (and there is every reason to hope that such will be the case) it would appear

that we have at hand a practical method which may be used for decreasing very materially one of the most serious losses to which the farmer is subjected.

THE PREPARATION OF A MIXED SERUM FOR THE TREATMENT OF HOG CHOLERA AND SWINE PLAGUE.

The experiments had shown that the serum prepared for the purpose of curing hog cholera was useful in protecting or curing small experimental animals from hog cholera only, and that serum prepared for the purposes of curing swine plague was useful in protecting from swine plague only. Other work had shown that if experimental animals infected with hog cholera were treated with a mixture of anti-hog cholera and anti-swine plague serum, that they responded generally a little bit more quickly to the treatment. Efforts were made therefore to prepare in one and the same animal a double serum, as it may be called. In order to do this, the animals which were to serve as a source for the serum were injected with hog cholera cultures and swine plague cultures, or their products, alternately or together, the doses being gradually increased until enough had been injected to impart to the serum the desired properties. The first tests upon experimental animals showed that a serum could be obtained in this way which exerted slight curative properties for both hog cholera and swine plague. The serum, however, was more active in checking swine plague than in checking hog cholera. The treated animals did not thrive under this treatment. The work, however, indicated the possibility of perhaps producing in the same animal a serum which may be specific for two distinct diseases. Experiments are being made now to ascertain to what extent this principle can be utilized in connection with other diseases of men and animals, especially tuberculosis.

CHARACTER OF IMMUNITY.

The length of immunity produced by the injection of serum is short and more permanent immunity can apparently be secured by using in addition to serum the products of the germs. The serum has appeared most efficacious in treating herds where the disease had just begun.

DIFFICULTIES IN FIELD WORK.

A very important difficulty which is encountered in field work is that it is almost impossible to determine in the field whether animals are suffering from hog cholera or swine plague, or from a mixed infection, unless a careful autopsy has been made. And even when this is done, on account of the similarity of many of the lesions found

in the two diseases, it is necessary to resort to a careful bacteriological examination of the cultures obtained from these animals in order to decide whether the disease dealt with is hog cholera or swine plague. This has already been pointed out in previous publications of this Bureau. On account of this practical difficulty the idea very naturally suggested itself that it would be well to treat animals in the field with a curative serum for hog cholera mixed with a curative serum for swine plague obtained from different animals or with a mixed serum produced in the same animal, as has already been noted. The quantity of the serum used for treating pigs weighing from 40 to 60 pounds was 10 c. c. When they were heavier a larger quantity was used. In general, in the experimental as well as the practical work that has been done by the Bureau, a single injection of the serum was all that was given to each animal. Unless the serum to be used for this work is of such strength that one-half to 1 c. c. of it will protect a 500-gram guinea-pig from a fatal inoculation with hog cholera or swine plague it is not suitable for practical work.

WORK IN PAGE COUNTY, IOWA, IN 1897.

The Secretary of Agriculture requested the Governor of Iowa to designate a county of the State of Iowa in which he would like to have experimental work carried on by the Bureau of Animal Industry. The Governor selected Page County. The serum for treatment was prepared according to the methods that have been previously noted, conjointly under the direction of Dr. Schroeder, in charge of the experiment station of the Bureau of Animal Industry, at Washington, and the writer, in charge of the Biochemic Laboratory. The field work in Page County was in direct charge of Dr. Marion Dorset. The methods of treatment used were the following: Sick animals were inoculated with serum that had been found in the laboratory to be effective against either hog cholera or swine plague, or the swine were inoculated with mixed serums, or they were inoculated with the serums to which had been added the products of the hog cholera and swine plague bacteria and their cell contents, or cultures in which the germs had been killed without the application of heat, that might in any way have affected the secretions of the germ.

In order properly to note the efficiency of field work of this sort it is very important that a large number of checks should be preserved. To accomplish this in some instances a portion of the treated herd was reserved and not given serum. In other instances herds in which disease existed of about the same virulence as that in the treated herd were left as checks.

The conditions under which animals are placed in all diseases of course influence very greatly the results of the methods of treatment used. *A child sick with diphtheria may be given an injection of*

antitoxic serum, but if after this injections the child is otherwise neglected it will in all probability not recover, as while the antitoxin counteracts the specific poisons of the diphtheria germ it does not give the further stimulation to the system which is also necessary for recovery. The case is similar in the diseases of animals. They should also be given proper care as to food, water, proper housing, and a modern degree of cleanliness if any method of treatment whatsoever is to prove satisfactory. Very often the farmer has himself to blame quite as much as an outbreak of some particular disease for the loss which takes place in his herd. If he treats his animals as inanimate he must not be surprised if they finally become inanimate, nor can he hope that when they are almost dead the administration of some remedy will miraculously serve to revive them. In many instances where the animals used in this work were treated the farms were in a very good condition and the owner exhibited a sufficient amount of interest, care, and intelligence to warrant successful results. In other cases the farms were very poor and the farmers seemed indifferent as to whether their hogs had anything to eat or drink for two or three days. In order therefore to give the fairest test possible to the method of serum treatment, the better farms were the ones reserved for checks.

FIELD WORK IN 1897.

To give the general results with the work carried out under the direction of Dr. Dorset, it may be stated that out of 196 animals treated with the mixed serums 161 were saved, or about 82 per cent. The disease existed on all of the farms where treatment was carried out, a number of animals had already died, and about 50 per cent of the animals treated were ill at the time of injection with the serum. In the check herds there were originally 429 animals, and the disease had begun both in these check herds and in the treated herds about the same time. In the herds, which were not treated, only about 15 per cent of the animals recovered. Comparing these two sets it would appear that the serum had reduced the mortality about 67 per cent. It is understood, of course, that all of the animals were under the same conditions after treatment as before. As a rule, the animals appeared to begin to improve very shortly after the injection of the serum. One herd was treated with a culture alone without any serum. Only 40 per cent of the herd so treated was saved. In another case a herd which was in a very poor condition at the time of inoculation was treated with a mixed swine plague serum and a dead culture. Eighty per cent of these animals were saved, while in a third similar case where the condition of the animals was very poor, only 30 per cent was saved. These results, obtained under rather adverse conditions, indicated that

serum injection for swine diseases could be practiced with a fair degree of success when the animals are intelligently treated with a mixed hog cholera serum and swine plague serum and bacterial products, provided these serums are active. The material used in this way is perfectly harmless, so that a farmer need have no fear whatsoever in allowing his animals to be injected; if it should happen not to effect the desired cure it will not injure the animal in the slightest degree. In general, of course, the sooner the treatment of sick animals can be begun the better will be the results of the treatment, but unless the reliability of the serum has been carefully tested and established experimentally, it does not necessarily follow that a sick animal which has been injected with a serum that is said to be efficacious will be cured. If in the case of diphtheria the mortality has been reduced 50 per cent by the serum treatment after long years of careful trial with thousands of cases, it is fair to assume that this method of treatment of swine disease is worthy of a more extensive practical experiment.

The character of the disease in the animals treated, as well as in the check herds in the year 1897, was determined by careful autopsy or, so far as possible, by the identification of the cultures made from the diseased organs of some of the animals upon which autopsy had been performed. In most of the cases examined the hog cholera germ was found present, and specimens of blood which were examined for me by Dr. Dawson, assistant in the Division of Animal Pathology of this Department, gave the characteristic reaction. The checking of the motility of the hog cholera bacilli, a reaction similar to that used for diagnosing typhoid fever, as has been suggested, might perhaps be useful in determining the character of diseases among swine in the field in a quicker way than would be possible if it was necessary always to work out the nature of the culture. While the majority of these blood examinations agreed with the culture tests, in a few instances the characteristic checking of the motility was observed in blood taken from animals which undoubtedly died from swine plague. These animals may have had in addition, however, a slight infection with hog cholera. At any rate, in chronic cases of disease in swine, when it is sometimes difficult to succeed in transferring to the laboratory a virulent culture from the diseased animals, it is probable that the blood test may be of service as a diagnostic agent.

So long as a serum is being used which has curative properties for both of the diseases to which the animals in the field are usually subjected, it is not of so much importance to be able to make a positive diagnosis or distinction between the two diseases. The acuteness of the attack is perhaps of more importance, as it serves to indicate the amount of serum which should be used in treating animals.

FIELD WORK IN 1898.

As the laboratory experiments and the field work of 1897 already reported had given such encouraging results, at the request of The Hon. James Wilson, Secretary of Agriculture, Congress made a larger appropriation which should be utilized during the year 1898 for making more thorough practical tests of this curative serum for swine. Unfortunately this appropriation was not made available as early as desirable. It was necessary after the needed funds were secured to erect additional stables to accommodate the large number of animals at the experiment station of the Bureau, to purchase the animals and other necessary facilities for carrying on the work. The experimental work in preparing the serum therefore could not be begun before the first of June, and consequently the amount of serum ready for use in the fall of 1898 was not so large as we had hoped, or as it might have been if the appropriation had been available three or four months earlier, when it was requested. Nevertheless, the field work was resumed again in Page County, Iowa. In July, Dr. McBirney, an inspector on the Bureau force, was put in charge of the work in that county, after being given instructions from the laboratory as to the quantity of serum to be used, the method of using it, the manner of treating herds, the method of keeping records, and so on. This work was carried out very faithfully by Dr. McBirney, according to the general directions furnished him, and the results reported up to date (December 1, 1898) have been exceedingly satisfactory and tend to confirm the results obtained in the year 1897. Between the 13th of July and the 11th of November, Dr. McBirney treated 35 herds containing 1,727 animals. Of these treated animals 403 died—a loss of 23.16 per cent in the treated herds. Cultures and specimens of blood were sent to the laboratory from most of these herds, and in 17 of the herds the presence of the hog cholera germ was demonstrated by tests upon experimental animals as well as by a careful study of the cultures. In 3 the presence of the swine plague germ was demonstrated. The examination of the blood and the motility test confirmed the presence of either hog cholera or swine plague, and indicated its presence in some of the herds the cultures from which had not given positive results. Autopsies were made upon one or more animals in each of these herds and records carefully kept. They indicated in many instances the presence of acute or chronic hog cholera, in a few cases swine plague, or a combination of both diseases.

Thirty-three herds in whole or in part were reserved as checks upon those which were treated. In some of these herds the character of the disease was also demonstrated by cultures or blood reactions. In others the autopsy indicated the character of the disease and hog cholera was found predominant. The number of animals in

these check herds was 3,197. Of these only 600 survived, or 81.24 per cent was lost. This shows about as large a percentage of animals saved in the treated herds as were lost in the nontreated herds and leaves apparently but little doubt as to the efficacy of practical treatment of swine diseases in the field by the use of these mixed serums alone or with bacterial products, combined with simple methods of disinfection and slight care which every farmer should be willing to give to his animals. The serum is intended to cure disease simply, and should have such aids as clean, warm quarters and good food and water; it is no protection against freezing, smothering, or starvation.

The results of our work so far warrant the following conclusions: Animals treated with the hog cholera germs, their cell contents and secretions, or those of allied germs, yield a serum which has curative properties for hog cholera. Similar results are obtained for swine plague by the treatment of animals with the germs or their cell contents and secretions.

The most satisfactory results in field work have been secured by treating the swine with a curative serum for swine plague mixed with a curative serum for hog cholera.

LOSSES FROM HOG CHOLERA AND SWINE PLAGUE.

It is estimated that the State of Iowa alone loses \$15,000,000 per year in the number of hogs that die from disease. The work, which has been carried on as above reported, indicates that at least \$11,000,000 of this loss might be avoided at a comparatively slight cost.

EXPENSE OF THE METHOD OF PREPARING AND USING SERUM.

The farmer should be able to have his hogs injected at a cost not to exceed 15 cents per head if the material for this purpose is prepared in a careful and legitimate way—for the benefit of the farmer rather than for the benefit of the manufacturer. If the latter simply desires to reap financial profits, irrespective of the fact that his material may or may not be useful, the results will undoubtedly be disastrous. Fifteen cents per head is but a trifle to the farmer if he is thereby enabled to save 60 to 80 per cent of his animals which would otherwise be lost.

SOURCES OF INFECTION AND NECESSITY OF DISINFECTION.

The fact that the cause of infection can be carried from one farm to another by animals, by birds, by water running through several farms on some of which disease exists, by the farmers themselves visiting the pens and lots where their neighbors have sick hogs, can not be too strongly emphasized. Disinfection of the premises, of the farmer's boots, clothing, of the wagons, etc., are absolutely necessary. Hence in all cases pens and lots should be thoroughly disin-

fectured with lime or 5 per cent carbolic acid, a pure water supply should be secured, and the hogs should from time to time have access to a mixture of salt, sulphur, and charcoal, or this should be put in their food. The animals should also have access to comfortable, well-protected sheds.

STATE SUPERVISION.

The results of the experiments conducted by the Bureau of Animal Industry indicate the advisability of certain State experiment stations carrying out this line of work in cooperation with the Bureau of Animal Industry.

Some expense is necessary for starting plants, building stables, and securing the animals, and a good deal of instruction for the men who undertake the work would be required. At the same time, as these experiment stations were inaugurated in order to advance the agricultural interests of the farmers, as they receive a very large amount of support from the National and State governments, it is presumed that they will gladly cooperate in every effort to promote the interests of the farmer. Undoubtedly commercial firms would be only too anxious to take up the manufacture of these serums, as the loss to farmers from these diseases of swine is so enormous. The moment that products of this sort, which can be so easily put up in a condition that they may be perfectly worthless and still appear satisfactory, are placed on the market for gain, the temptation is so great to sell an inefficient material that very often unsatisfactory results may be obtained and great discredit thrown upon the entire work. If private firms undertake the manufacture and sale of serum for treating swine, their products and prices should be subject to legal supervision. If the public is protected against the sale of utterly worthless fertilizers, as is the case in many of our States, most assuredly the sale of a material which may prove so essential to the farmer should also be subject to legislative control. No lot of serum should be sold unless it had been approved, and its value as a curative agent tested, by careful official inspection and trial. As the Bureau of Animal Industry has now a plant for the manufacture of this material, has obtained a great deal of very valuable experience, and has worked out the theoretical and some of the practical principles of the use of serum which promises such good results in treating swine, it is probable that for several years to come at least those who are working along these lines will prefer that the control of this material should remain either directly in its hands or under its supervision. The Bureau is endeavoring to push the work, and to supply larger and still larger quantities of serum for use, and will carefully note and report the results.

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BULLETIN No. 24.

(B. A. I. 134—Dairy No. 28.)

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.

NOTES UPON DAIRYING IN CALIFORNIA

AND

THE EXPORT OF CALIFORNIA BUTTER
TO THE ORIENT.

BY

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Prepared under the direction of
Dr. D. E. SALMON,
Chief of the Bureau of Animal Industry.



WASHINGTON:
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1900.



LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., October 31, 1899.

SIR: I have the honor to transmit herewith a manuscript entitled "Notes upon dairying in California and the export of California butter to the Orient," prepared by Mr. R. A. Pearson, assistant chief of the Dairy Division.

Mr. Pearson recently visited California under your orders, and this report of his visit is prepared in accordance with your direction. The California State Fair and the annual convention of the State Dairymen's Association were attended with a view to meeting representative men and inquiring as to the present condition of the dairy industry in that State and the possibilities of supplying dairy products suitable for export from the Pacific coast.

This paper contains numerous suggestions which may be of special interest to California dairymen at this time, and I recommend its publication as a bulletin.

Respectfully,

D. E. SALMON,
Chief of Bureau.

HON. JAMES WILSON, *Secretary.*

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NOTES UPON DAIRYING IN CALIFORNIA AND THE EXPORT OF CALIFORNIA BUTTER TO THE ORIENT.

THE STATE FAIR.

The California State fair at Sacramento, September 4 to 16, 1899, was said to be the most successful ever held by the State board of agriculture. The number of exhibits was larger than in previous years and the number of visitors had never been equaled. Although the dairy features of the fair were overshadowed by the exhibits of fruits and vegetables, which were shown in great number and variety, and by the usual displays of agricultural products and implements, a very creditable showing was made of dairy stock, implements, and products.

DAIRY LIVE STOCK.

In the live-stock department were representatives of the leading milk breeds of the State—Jerseys, Holsteins, and Shorthorns—and not a few of the animals showed high merit, capable of taking prizes in many Eastern fairs. The exhibit demonstrated that at least some of the breeders of the State are well to the front in their work. There were fewer animals shown than would have been expected from so large a State. One reason for this was the small number of registered herds in California as compared with other dairy States, and another was the lack of sufficient interest on the part of owners of well-bred stock. There are numerous herds of blooded dairy cattle throughout the State; but it appears that the benefits of showing at the fair are not considered equal to the drawbacks, one of the greatest of which is the long and expensive haul to and from the fair. Without strong inducement, a breeder of fine cattle will not subject his animals to the excitement of travel and noisy crowds.

DAIRY MACHINERY.

The displays of creamery and dairy machinery and utensils were quite similar to what would be seen at a large Eastern fair; in fact, much of this apparatus is furnished to California supply houses from Eastern factories. On an elevated platform the operations of a working creamery were carried on daily. This instructive feature is commendable and worthy of imitation. The time and place of such an

exhibition should be thoroughly advertised, so that all who might want to see it would know about it.

BUTTER.

About thirty samples of butter—in squares, rolls, tubs, and small export packages—were entered for prizes. It was in three classes—fresh, June storage, and packed for export. Six prizes—\$30, \$25, \$20, \$15, \$10, and \$5—were offered in each of the first two classes, and three prizes—\$25, \$20, and \$15—were offered for export butter. Although these prizes did not attract an exceptionally large number of entries, the competing samples were representative of all sections of the State and they were uniformly of high quality. The butter was judged by Mr. W. D. McArthur, of San Francisco, a temporary special agent of this division, and the writer. The following table gives the names of exhibitors, their addresses, and scores. In order to show the districts where the exhibited samples were produced, the State is divided into five parts of about equal size, by imaginary east-and-west lines; these are designated from north to south by the letters A, B, C, D, and E, respectively, and the letters are shown in the first column of the table:

Scores on butter at the California State fair, September 13, 1899.

Exhibitors.	Sec- tion.	Flavor (50).	Grain (25).	Color (10).	Salt (10).	Appear- ance (5).	Total (100).
FRESH.							
Alton Creamery Co., Alton.....	A	47½	23½	10	10	5	96½
Eel River Creamery Co., Ferndale.....	A	47½	23½	10	10	5	96½
Geo. E. Peoples, Bakersfield.....	D	47½	23½	10	10	5	96
O. J. Vine, Lakeport.....	B	47½	23	10	10	5	95½
G. G. Knox, Grafton.....	B	47½	23	9½	10	5	95½
Allen Quain, Stockton.....	C	47½	23	10	10	5	95½
Joseph Sheppard, Point Arena.....	B	47½	22½	10	10	5	95
O. E. Jones, Newman.....	C	47½	22½	10	10	5	95
Lockeford Creamery Co., Lockeford.....	C	47	22½	10	10	5	94½
J. N. Keiser, Hollister.....	C	46½	22½	9½	10	5	93½
J. A. Howie, Compton.....	E	46	22½	10	10	5	93½
Warren Myers, Woodland.....	B	45	23	10	10	5	93
C. A. Starkweather, Oakdale.....	C	46½	22	10	9½	5	93½
W. T. Mitchell, Susanville.....	A	46½	22½	9	10	5	93½
Geo. E. Newman, Lompoc.....	E	45	22½	10	9½	5	92½
JUNE STORAGE.							
W. M. Twiner, Sierra Valley.....	B	45	23	10	10	5	93
E. H. Zimmerman, Watsonville.....	C	44½	22½	10	10	5	92½
J. H. Keiser, Hollister.....	C	44	23	10	10	5	92
D. Brough, Newman.....	C	44	22½	9½	10	5	91½
A. J. Bloom, Petaluma.....	B	44	22	10	10	5	91
Bailey Bros., Crescent City.....	A	43	22½	10	10	5	90½
W. T. Mitchell, Susanville.....	A	42½	22½	10	10	5	90
O. J. Vine, Lakeport.....	B	42	23	10	10	5	90
O. E. Jones, Newman.....	C	42½	22½	9½	10	5	89½
C. A. Starkweather, Oakdale.....	C	42	23	10	10	4½	89½

Butter in small cans for export.

[Cans scored equally; judged on quality of butter.]

Dairymen's Union of California, San Francisco, first premium for butter in paraffined paper can; Hilmer, Bredhof & Schulz, San Francisco, second premium for butter in lithographed tin can; Sussman, Wormser & Co., San Francisco, third premium for butter in lithographed tin can.

Both first and second prizes on fresh-made butter went to creameries in Humboldt County, a large county near the northern boundary of the State, bordering on the ocean, and possessing exceptional advantages for dairying. Some well-informed dairymen claim that this county is the best natural dairy district in the world. The third prize on fresh-made butter was taken by a creamery in the southern part of the State. The fourth and fifth prizes went to the district just north of an east-and-west line through San Francisco, and the sixth prize to the district just south of the same line. All of the entries of storage butter were from the central and northern parts of the State.

It happened that the Humboldt County creameries had a distinct advantage over most of the others in the State at the time the fresh butter was made for the fair, as many factories elsewhere were then receiving milk from patrons whose pastures were suffering on account of the dry season, and undesirable flavors could not be avoided, while the pastures in Humboldt were in good condition. The aroma and flavor of the Humboldt County butter were excellent. It was also exceptionally well made and well packed, as was shown by the fact that it stood the three days' journey by boat and rail from the creameries to Sacramento without unusual protection. It was in the regular California squares, described on page 25. Other entries were in small tubs.

Butter in hermetically sealed pound packages for export was exhibited in small quantity. The judges deemed it best not to attempt to decide the merits of the different packages, as the experimental shipments of butter from the Pacific coast to trans-Pacific ports, now being made by the United States Department of Agriculture, are partly for the purpose of testing the several packages available for shipments without refrigeration to tropical points. Therefore in this class prizes were awarded on the basis of the quality of the butter in the cans; and in this respect there was considerable variation, some of the samples being decidedly rancid. These small cans had been exposed for several days to high temperatures. Possibly they were thus put through more unfavorable conditions than would be encountered on a voyage to the Tropics, but this was probably not the case. They again showed that hermetically sealed cans will not, under all circumstances, preserve the good qualities of butter, as some people seem to think they are capable of doing.

THE DAIRYMEN'S ASSOCIATION.

The sixth annual meeting of the California State Dairymen's Association was held during the State fair at the capitol building. It was attended by leading dairymen, creamery men, and cheese factory men from all parts of the State. Representatives were present from commission houses in San Francisco and Sacramento. The State Univer-

sity was well represented, and the sessions were visited by prominent citizens. The press of the State gave liberally of its space in reporting the proceedings. A regular programme had not been prepared, as it was thought best to occupy the time with informal discussions on the special subject which the secretary had announced in advance, namely, "The export of dairy products from the Pacific coast." The topic was opportune, and its various phases were taken up and discussed in a logical way. A brief résumé of the facts brought out in the discussion follows.

THE INCREASE OF BUTTER PRODUCTION.

First, it was pointed out that dairying in the older States is being promoted and encouraged by various agencies, such as well-equipped dairy schools, live dairy associations, and efficient State dairy commissioners. And it is now being extensively developed as a new industry in certain large sections of the United States where only a few years ago cows were seldom seen. As examples of this recent dairy growth the activities in Georgia and the Dakotas were referred to. All this shows that our home markets will continually be more and more plentifully supplied, and in many cases competition will be keen.

It was stated that the production of dairy products in California is increasing and in some sections very rapidly. This is not surprising when one considers how the industry is favored by many natural conditions, of which too much could hardly be said. The mild climate, splendid natural grazing, and the tremendous crops of alfalfa which can be raised at small cost almost make it seem that California has been favored above all other States. Many of the great wheat ranches are gradually adopting dairying as a secondary interest, and some of them have gone into it farther than they had originally planned. Large herds of dairy cows (Pl. I, fig. 1) are becoming common, and the owners of less than one hundred cows refer to their "small herds" very much as an Eastern dairyman would speak of his fifteen or twenty cows. New creameries are in operation at many points. Besides the advantages named, the markets for dairy products have been good. It has been possible for the California dairyman to produce cheaply and sell well. It is therefore not unlikely that the growth of dairying will continue, and within a few years more butter and cheese will be made than the home market will require. California dairymen will then face conditions similar to those already met in the Eastern markets.

FOREIGN MARKETS FOR SURPLUS.

In the second place, the possibilities of finding markets for surplus in countries bordering on the Pacific Ocean were discussed. Although some of those lands fairly swarm with people, only small quantities of dairy products are sent to them, and these supplies are chiefly for the few foreigners who are there—Americans, English, Germans, and

French. As a rule the natives have not yet learned to use butter and cheese, but extracts from consular reports were read which showed that in some cases they are commencing to eat dairy products and a gradual increase in their demands may be expected. With improvement of domestic and commercial conditions, new tastes are developed and new wants are manifested. This is shown in the upward growth of every nation. Just at this time the changes which are taking place in some Asiatic countries are attracting the attention of the world. Every commercial nation is looking for new trade in articles not before called for, and in this respect California merchants propose to take an important place. American flour is a product which has successfully established a market for itself within the past few years. Large quantities are now shipped to places where it was once prophesied flour would never be commonly used. Other illustrations could be given of American products which have found favor. Judging by the success along other lines and by the small beginning already made by our butter and cheese, the Western dairymen have good reason to feel encouraged in their hopes of finding large markets across the Pacific. And it may be profitable to have such an abundant surplus that regular and frequent shipments can be made, at least during the season of greatest production, at which time there will be but little competition from dairy countries south of the equator.

Furthermore, attention was called to the fact that most of the small amount of butter going to the points referred to is now supplied by Denmark, France, and Australia, and, as a rule, the products from these countries are sold at prices in excess of what is paid for "States goods." In other words, the present limited demand for dairy products in the far East is being supplied chiefly by our competitors, and they frequently receive as high as 50 cents per pound for their butter. The California dairymen should, and many of them do, appreciate that the best way to assure themselves of enjoying a large share of the future trade with the Pacific countries is to secure and hold a large share of the present trade with those countries.

PREPARATION OF BUTTER FOR WARM CLIMATES.

It having been shown that there may soon be a surplus of dairy products available for export, that in the near future large markets for these products may be developed at trans-Pacific points, and especially that the United States does not share in the present trade to the extent that she should, the next question considered was how butter should be prepared for shipment to warm climates. There was an interesting discussion on the various phases of this question, participated in by dairymen, creamery men, and scientists, and numerous ideas of practical value were advanced. The want of refrigerated compartments for ocean transportation makes the problem quite different from what it is in the East.

As to the kind of butter wanted, all agreed that for export without refrigeration it should be of particularly hard body and high melting point. More stress was laid on this than on the necessity of its having a high flavor. A clean, mild flavor is wanted, and an article of close texture, with a dry, solid body and capable of resisting the effect of heat as much as may be. At the same time producers were warned not to make such butter except for foreign trade, as it would not sell as well as the regular creamery in home markets.

Causes affecting hardness of butter.—It is believed that the body, or hardness, of butter is largely within control of the feeder and butter maker. It is thought by some that butter made from milk containing large fat globules has a lower melting point than that made from milk containing small fat globules. According to this theory, butter from Channel Island stock would be softer than that from the so-called "cheese" breeds, a proposition that was opposed by not a few. It was stated, also, that butter made from milk taken during the latter part of the period of lactation is harder than that from milk taken soon after calving. That the body of butter can be easily affected by variations in manufacture is well known.

An important cause of difference in hardness is supposed to be difference in the relative proportions of the component parts of the butter fat caused by various kinds of feed. An increase in the stearin and palmitin, which are solids at ordinary temperatures, and a corresponding decrease in olein, which is an oil at ordinary temperatures, would cause butter to be harder, while changes of an opposite nature would make it softer. Practical experience and a few experiments show that the hardness of butter can be affected to a certain extent by the feeds given the cows. It was generally agreed that butter is made hard by the addition to the ration of a small amount of potatoes; cotton-seed meal has a similar effect, but too much of it will taint the butter. One person said oat hay and green corn fodder also have somewhat the same effect. On the other hand, linseed meal causes soft butter, and alfalfa hay when used alone does the same. An instance was given of a herd which had been fed on alfalfa and Bermuda grass and was changed to a pasture of young barley that had dried up before it was fully grown. The butter immediately became very hard. A commission merchant reported that the butter from one of his shippers suddenly became hard and would not melt as readily as usual. Upon investigation it was found that the herd had recently been turned onto a stubble field. Sugar beet pulp and tops were not discussed, but some facts about them are given below.

Method of making.—No special points were brought out regarding the manufacture of butter for the new trade. The ordinary methods are followed, but the necessity of using great care in every step of the work, so as to produce the highest grade article, was emphasized. The butter maker should discard all dirty milk. He can not afford to

introduce into the butter millions of bacteria of many species, which may cause bad flavors, when they can easily be excluded. It was recommended both to wash and to work the butter a little more than usual, to get out as much as possible of the casein, albumen, and sugar, which are excellent materials for bacteria to feed upon. Even when all possible precautions have been taken there will still be many bacteria in the finished product. Coloring and salting need not be different from the home requirements, unless to comply with special orders. It is the practice to do the canning in the butter cellars at San Francisco, using any butter sent to that market that appears to be satisfactory. The butter can be cut from large packages in lumps of proper size for the cans, so that reworking it is not necessary. Probably this method will obtain until a regular export trade is developed which will make it more economical to install canning appliances in the creameries.

The packages should be as nearly sterile as practicable at the time they are filled. They may be easily sterilized by exposure to steam in a tight chest of wood or galvanized iron. In packing, care should be taken to exclude the air as much as possible by having the butter completely fill the can. This is for the double purpose of keeping out bacteria which might be floating on dust particles in the air and to avoid furnishing one of the essentials for growth to those bacteria in the butter which can not develop without air. After the can is sealed some change takes place, unless it is held in cold storage, and this does not seem strange when it is remembered that, in spite of all the care which may be taken, some air will be in the cans and the butter is very likely to contain some bacteria which can thrive even in the absence of air. Thus it is seen that although hermetically sealed packages have many advantages they are not a panacea. The problem is not yet satisfactorily solved.

Preservatives.—There is a disposition on the part of some to use preservatives to hold bacteria in check, and various compounds of this class are on the market and are very strongly indorsed by those interested in their sale. Many misleading statements have been made in their favor. It has not been scientifically demonstrated whether preservatives in butter are harmful to consumers or not, but dairy scientists and leading dairymen strongly object to them on general grounds and the laws of some States forbid their use. It is interesting to note that Danish butter, which holds the first place wherever it is sold, is free from preservatives, and it is almost unnecessary to add that no preservatives are or have been used in butter sent abroad by the United States Department of Agriculture. It is to be hoped that the California dairymen will not adopt them until an unquestioned authority has plainly shown that their advantages exceed their disadvantages. Their general use at this time might cause great injury to the fair reputation the State is seeking for its dairy products. A

resolution condemning their use was adopted by the Dairymen's Association.

It is argued that in some respects the process of digestion is similar to fermentation, and that any substance which stops the usual changes in a food product will also affect its digestibility. Furthermore, some and perhaps all of the active chemical substances in preservatives have distinct influence on the functions of certain organs of the body. No one cares to take a dose of medicine without need of it, much less regular and frequent doses of an unknown substance, even though they are small, and many persons would prefer to go without a certain food than to run such a risk. Still another objection to preservatives is the fact that they make it impossible for the butter maker to control the cream ripening and the development of desired flavors. As a matter of fact the effect of preservatives could be made unnecessary in most cases where they are used. A few milk producers and butter makers have unfortunately learned that these substances are, so far as appearances go, a fair substitute for cleanliness. By improving their methods they could do away with the use of the questionable compounds and enjoy a clear conscience in delivering to their customers goods known beyond a doubt to be pure. Preservatives do not wholly stop bacteria from growing and multiplying, and it is safe to say that by observing scrupulous cleanliness pure butter could be made which would keep as well as or better than the ordinary kind preserved. The pasteurization of milk for making butter for export is practicable, and it may be that this, in connection with cleanliness, will be the true solution of the problem.

Packages.—A round tin can holding 1 pound is the favorite package. Until quite recently all the joints of the can have been closed with solder, but now a special machine is used for fastening the top without solder, thus doing away with the necessity of applying heat to the can after it is filled. It is important to have the cans made of a good quality of standard tin (tin weighing about 100 pounds to the box has given satisfaction), and special care should be used to have them smoothly finished. The inside of the can is usually paraffined or lined with parchment paper; sometimes both paraffin and parchment paper are used.

The sale of butter always depends to a varying extent upon the appearance of the packages, and among the oriental people appearance has a decided influence. They like neatness and decoration, and therefore it pays to finish the cans in a way that will please them. Seals, trade-marks, fancy figures, and lettering are recommended. Paper labels soon become soiled, rubbed, and torn, and cans thus marked will be passed by for prettily lacquered ones. Some buyers attach more importance to the appearance of the packages than to the quality of their contents. There is no doubt that an official seal or stamp

showing inspection by an authorized person would often serve as a guaranty and aid in sales. Cans opened by removing with a "key" a narrow strip of tin from the side near the top have an advantage over the old-fashioned style and are much preferred in some markets.

SOME PURPOSES OF THE DEPARTMENT'S EXPORTS.

During the discussions on the general subject of exports an account of the efforts of the Department of Agriculture to find and develop new markets for our dairy products was given. A letter from Maj. H. E. Alvord, Chief of the Dairy Division of the Bureau of Animal Industry, Department of Agriculture, was read and received with applause. It told of the experiments already made in exporting high-grade butter to the English market, and explained the purpose of the Department to conduct similar experiments from the Pacific coast, by sending small lots of selected butter and cheese to a half dozen of the largest seaport cities of Japan and China, to show that the best grades of dairy products can be procured in this country, and to obtain information as to the best ways of shipment. It was pointed out that while a temporary overproduction of butter or cheese can be easily cared for and kept off the market by our excellent storage facilities, a continued production of goods of high grade in excess of the home demand would result seriously to the dairy interests by causing a fall of prices, unless a profitable outlet could be found for the surplus. This fact commends to all dairymen any efforts to extend markets for milk products. Whether they are personally interested in exporting or not, their welfare may largely depend upon the success of those who are engaged in foreign trade.

It is most important for our butter and cheese to bear a good reputation in all foreign markets, so that they will be received at their true value at any time they are offered for sale, and this thought was plainly brought out by several speakers. Such a desirable condition does not now exist, owing partly to the fact that a large proportion of the dairy products sent out from this country is inferior in quality. This is well known to be the case with shipments from New York; it is also true of shipments from San Francisco. Some of the Western merchants argue that, as the butter will be somewhat off flavor anyway when it reaches its destination, it will make little difference if it is just a bit inferior when it starts! This mistake is largely responsible for the fact that our butter in cans sells in many places at prices 25 to 50 per cent lower than the goods from other countries.

Much interest was shown in the efforts of this Department to improve present conditions and there were many liberal offers of assistance. Especially was this generous spirit shown by some creameries that were willing practically to place themselves at our disposal for the preparation of goods for export. The possible needs of the

Department were fully discussed with the officers of one well-equipped plant and they will hold themselves ready to fill any requirements on short notice.

THE PRESENT EXPORT TRADE.

A short time was spent in San Francisco arranging details in connection with our experimental exports. Although the three steamship lines to Hawaii, Japan, and China have more than they can do and are now refusing freight, their officials showed an interest in the work of the Department and agreed to assist in the experimental exports by carrying our consignments whenever offered. They do not have much call for service in refrigerated compartments and nothing of this kind is provided.¹

By referring to the table below it will be seen that present shipments of dairy products would not justify transportation companies to go to very great expense for their exclusive accommodation. Nor is it now possible for this Department to guarantee to the steamship lines payment for freight on the full capacity of their refrigerators if not filled, as the Canadian government has practically done in some instances, to the great benefit of her dairy interests. The three principal trans-Pacific countries to which butter and cheese are sent from the United States are Japan, China, and Hongkong, and the amounts these countries and the Hawaiian Islands have received in recent years are shown in the following table. Of course, most of the shipments to these countries from the United States are from the Western ports.

Exports of butter and cheese from the United States to Japan, China, Hongkong, and Hawaiian Islands, 1893-1899.

[From Commerce and Navigation of the United States, Treasury Department.]

Year ended June 30—	Japan.		China.		Hongkong.		Hawaiian Islands.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
BUTTER.	<i>Pounds.</i>	<i>Dollars.</i>	<i>Pounds.</i>	<i>Dollars.</i>	<i>Pounds.</i>	<i>Dollars.</i>	<i>Pounds.</i>	<i>Dollars.</i>
1893	56,664	11,402	5,789	1,303	7,491	1,793	114,355	23,253
1894	58,189	11,534	5,768	1,312	5,000	1,048	72,578	15,992
1895	77,001	14,007	5,528	1,097	1,165	245	122,856	23,068
1896	101,751	18,103	20,277	3,709	3,536	708	128,847	23,243
1897	87,180	15,654	25,336	4,621	3,850	725	127,037	22,808
1898	115,203	23,097	21,555	4,688	13,315	2,779	152,367	34,561
1899	92,495	18,592	22,337	5,159				
CHEESE.								
1893	10,480	1,355	31,009	4,122	15,348	1,989	77,158	9,944
1894	14,153	1,884	29,104	3,777	9,973	1,323	80,787	10,290
1895	13,051	1,553	28,787	3,507	17,367	2,052	87,615	10,113
1896	31,960	3,603	35,290	3,779	16,681	1,922	93,795	10,761
1897	40,965	4,433	41,690	4,589	81,380	9,168	100,585	11,073
1898	35,594	3,867	44,264	4,817	93,205	10,106	138,975	14,975
1899	52,580	5,965	101,950	11,161				

¹It is reported that a refrigerator plant has just been installed on a sailing vessel between San Francisco and the Hawaiian Islands and refrigerated compartments will open for perishable articles.

In this connection it is interesting to note that thus far the total shipments from the Pacific coast have not been large. The following table shows the exports of butter and cheese in recent years from the two principal exporting districts—San Francisco and Puget Sound. By comparing the two tables it will be seen that only a small part of the total exports are sent across the ocean. As a rule, less than 25 per cent of the butter leaving the Pacific coast goes to China, Japan, and Hongkong. A large proportion of the exported butter is packed with brine in firkins.

Exports of butter and cheese from San Francisco and Puget Sound, 1893-1898.

[From Commerce and Navigation of the United States, Treasury Department.]

Year ended June 30—	San Francisco.		Puget Sound.	
	Quantity.	Value.	Quantity.	Value.
BUTTER.				
	<i>Pounds.</i>	<i>Dollars.</i>	<i>Pounds.</i>	<i>Dollars.</i>
1893	409,428	84,242	6,116	1,589
1894	444,740	92,538	25,695	5,569
1895	333,596	60,621	35,367	7,279
1896	386,422	69,144	49,118	9,497
1897	421,191	74,268	113,676	21,915
1898	525,490	113,743	93,740	20,446
CHEESE.				
1893	227,491	29,712	11,301	1,252
1894	239,580	31,176	2,628	386
1895	218,805	26,374	6,502	696
1896	246,773	28,107	5,957	720
1897	352,202	39,225	19,664	2,499
1898	382,850	41,463	12,623	1,707

UNNATURAL CONDITIONS OF HOME MARKETS.

Although as much butter is probably made in California as is used in the State, the production is so uneven that at certain seasons of the year it is found necessary to import from the East. Large quantities of cheese are also sent from New York and Wisconsin to supplement the output of the home factories. Frequently the goods shipped in are not the best. They usually sell well, however, as they meet little competition with superior grades. This peculiar condition will not last when the Coast production has further increased.

DAIRY MANAGEMENT.

The various grain feeds commonly used by dairymen in the East are seldom used in California. The feeding stuffs principally depended upon are natural pasturage, alfalfa, roots, and hay. The climate is so mild that the pasture season is unusually long; in fact, in some districts it has no end. In Humboldt County grain is not fed; cows are pastured the entire year. The pasture is principally red clover and Italian rye grass, and it is supplemented in fall and winter with green peas, carrots, beets, corn fodder, and hay. That the cattle do well with this care is shown by the fact that some herds of grade stock average over 300 pounds of butter per year, and the cows, as a rule, are in good condition.

In the alfalfa districts one hears almost incredible reports concerning the productiveness of the soil. Enormous crops are common, and five or six cuttings a year are not unusual. Irrigation is practiced to a considerable extent. Here, too, grain is seldom used. When cows are grazing they are usually given a small amount of hay at night, and a little bran is occasionally fed. One dairyman, who paid \$175 an acre for his 40-acre ranch, reports that he receives about \$100 per month from the creamery for the milk of his 30 cows. He uses no grain, pastures eight months, and feeds hay four months each year. His herd consists of ordinary grades and fairly represents many others which have been built up within a short time from stock which is better for beef production than for the dairy.

It is stated on good authority that a dairyman in Yolo County fed 90 milch cows in a corral from March 10 to July 18, 1897, on alfalfa cut from 32 acres. No other feed was used. The cows gave satisfactory results in milk yield and were in better condition at the close of the period than at the beginning. The custom of keeping cattle out of doors is made possible by the prevailing mild climate. On many ranches the animals never go under a roof to be milked or for any other purpose.

These facts make it evident that the California dairymen have good cause to boast of their ability to produce milk cheaply. As might be expected, they have much room for improvement. They admit that in many ways their methods are extravagant and not a few of them are leading in movements toward economy. The more careful selection of cows for the dairy and especially the selection of good stock for breeding is a line of improvement which would show splendid results. This general subject was fully discussed in an early bulletin of the Dairy Division of this Bureau (Dairying in California), and need not be further referred to here.

BEET-SUGAR BY-PRODUCTS.

But something should be said of the use as feed of sugar-beet pulp and tops, which, though comparatively recent, is very common in some localities. Sugar beets are extensively raised in the vicinity of beet-sugar mills, of which there are several in the State. Three such districts were visited, namely, Alvarado, Watsonville, and Salinas. As a matter of general interest, it may be stated that a good crop of beets runs about 15 tons to the acre, and the price for the year 1899, as agreed upon in advance by the sugar companies and the farmers, is \$4.50 per ton. During the harvesting season there is on some days an almost continuous procession of two, three, four, and six horse beet wagons on every important road leading to the factories. The roots are loaded onto strong nets in high wagon racks and are quickly



FIG. 1.—A CALIFORNIA DAIRY HERD.



FIG. 2.—COMBINED DAIRY AND SUGAR-BEET RANCH.



tumbled into the bins by raising one side of the net with the aid of a steam engine and tackle.

Sugar-beet pulp.—Sugar-beet pulp,¹ which is the principal by-product in the manufacture of beet sugar, is usually sold for 25 to 30 cents a ton at the factory. Last year the price was as high as 50 cents. As it can be held a long time in silo and is fed to best advantage when old, it is available the entire year. The use of fresh pulp is said to reduce the milk flow. It is supposed to be good when a few weeks old and better at six months, and will keep two or three years.

When fresh the pulp is piled or placed in a silo (Pl. II, fig. 1) where it remains undisturbed until needed for use. The material is so soft and moist that if a large pile is dumped in the corner of an inclosed space it will gradually settle until the surface is almost level. Of course the top part decays, and after a time the entire mass is covered with a protecting layer from 3 to 6 inches in thickness. Within a few months the individual pieces of beet which were originally 2 or 3 inches long and quite slender are broken down, and the appearance of the material reminds one of cold mush, grayish brown in color. Three tons of fresh pulp make about 1 ton cured.

Pulp has a tendency to fatten and it is given to beef cattle without the addition of any other food, but for milch cows its effect is found to be best when used with a little grain or hay. Without these latter it is supposed to produce a thin and watery milk. One feeder uses corn with pulp, another feeds about 3 pounds of bran daily. When pulp is fed in considerable quantity the animals do not care for water and may go for months without a drink. A feeder who has been using this by-product several years complains that when his cows have been fed for a long time on pulp their calves are likely to come weak and be troubled with scours. Another dairyman of less experience who feeds the pulp fresh states that in his observation it has no bad effect on the calves.

A herd of 200 milch cows kept near a beet-sugar factory about 40 miles south of San Francisco is given a daily ration of 60 pounds of pulp, 5 pounds of mixed ground grain, and a little hay. The cows were seen in the pasture and appeared to be in good health and flesh. The milking cows averaged almost 2 gallons each per day. Their

¹ The average analysis of diffusion pulps is given by Mr. G. L. Spencer in the 1898 Yearbook, as follows:

Moisture	89.09
Nitrogenous matter	.92
Digestible carbohydrates	6.52
Indigestible carbohydrates	1.98
Fat	.09
Mineral matter	1.40
Total	100.00

milk is shipped to a dealer in San Francisco, who pays $12\frac{1}{4}$ cents per gallon for it the year through and $1\frac{1}{4}$ cents per gallon for railroad freight. The production is greatest from February to May. Butter made from milk of this herd, for experimental export, was found to have exceedingly good body, a satisfactory flavor, and an apparently first-class keeping quality.

On a ranch near Watsonville, which supplies milk to a creamery, pulp has been used a few months each year for the past eight years. About 100 pounds a day are given to each animal.

It is the general opinion that pulp causes the butter to be hard.

Sugar-beet tops.—By “beet tops” is meant the leaves and the extreme top parts or crowns of the beets cut off when the beets are being piled ready for hauling. They are available during the harvesting of the crop, which lasts about three months. (See Pl. II, fig. 2.) This portion of the crop has some fertilizing value, and it is often plowed under on that account. Indeed, some beet-sugar companies which own large tracts of land forbid the removal of the tops. But considerable quantities of beet tops are fed and good results are claimed. The market value of this feed depends almost entirely on the prices of other feeding stuffs. When feeds are high, tops sell for \$3.50 to \$4 per acre on the ground; this year (1899) the price is about \$2.50. It is best to allow the tops to wilt two or three days before being gathered and fed. They are then easily handled and not as liable to physic the cows as when used fresh. If they become crisp, a few green leaves are mixed with them before feeding. Unlike the pulp, they cause the animals to desire a large amount of water. Many farmers feed the tops alone, but it is claimed to be better to use a little bran with them. Evidently they are satisfactory to the cows, as little else is eaten when the cows are turned out to pasture. Some people claim that beet tops give a peculiar flavor to the butter, but only a few made this criticism.

One dairyman brought his entire herd of 90 grade Durham and Holstein cows from his own ranch to a beet farm where he had bought the privilege of using the tops. After the crop has been gathered he will move back to the home place. At the date of the visit of the writer the cows had been fed on beet tops five days and were running on wheat stubble. The owner stated that their milk yield had doubled in that short time, the average being almost 2 gallons a day. Before the removal, hay was the principal feed. This man makes the butter himself and sells it in the local market at highest San Francisco prices. It is always hard when he is feeding beet tops. A dairyman who feeds beet tops two or three months each year states that one September he sent a barrel of butter made from beet-top milk to a mining camp. It was packed in rolls and covered with brine, and it lasted so long, remained hard, and kept so well under unfavorable conditions that it attracted much attention, and orders were received for more of the same kind.



FIG. 1.—SUGAR-BEET-PULP SILO.



FIG. 2.—WILTED BEET TOPS FROM THE FIELD READY FOR FEEDING.



CALIFORNIA CREAMERIES.

There are about 300 creameries in California, and, judging by the few visited and what was reported of many others, they are well equipped and capable of doing good work. It appears that they are, as a rule, profitable investments. The charge for making butter is commonly as high as $3\frac{1}{2}$ cents per pound, and until quite recently creameries charged $4\frac{1}{2}$ cents. One establishment, now receiving daily 10,000 pounds of milk from 70 patrons and averaging about 7 tons of butter per month, has been in operation four years, and during that time almost \$5,000 from the regular earnings have been invested in permanent improvements, besides paying good dividends. Inasmuch as it took some time to grow from a small beginning, this is a good record.

As a rule, the creameries run every day of the year. The output of the one just referred to, which is in an alfalfa district, is largest in May, being $8\frac{1}{2}$ tons last May; in April 8 tons were made; in November $6\frac{1}{2}$ tons; and in December $5\frac{1}{2}$ tons, the smallest monthly output.

In equipment the creameries are quite similar to those in the East. Box and combined churns, separators, vats, in fact, practically all of the apparatus, is from the East. One plant, receiving in September, 14,000 pounds of milk a day and the cream of as much more from its two skimming stations, uses an ice-making machine capable of producing 3 tons of ice in a day; the direct expansion system is used. A large tank of brine is suspended near the top of the butter room, and when it is desired to shut down the ice machine the brine is thoroughly cooled and it keeps the temperature in the workroom low until the machinery is again started. This creamery had the honor of making and packing in 3-pound cans 3 tons of butter for the U. S. S. *Oregon* for her famous trip around the Horn. The butter was made in the usual way, except a little drier. It was reported to have been good to the last.

PAYMENT FOR MILK.

The method of payment for milk, as explained at two cooperative creameries, is as follows: Composite samples of each patron's milk are tested by the Babcock test once or twice every month, and a statement of the amount of milk delivered by each person and the average tests is handed to the secretary early in the following month. The total amount of butter made and any deliveries to patrons are also reported at the same time. The secretary computes the amount of fat brought by each patron and the total. The overrun is then determined (and it is usually found to be about 16 per cent). The fat delivered by the different patrons is increased in the proper proportion and each is credited with the delivery of a certain number of pounds of butter. The receipts from sales of butter made during the month are reduced by the creamery charge for making (3 or $3\frac{1}{2}$ cents per pound), and the net

average rate to be paid to the patrons is determined by dividing the amount of money remaining after this reduction by the number of pounds of butter delivered. The amount due each patron is then found by multiplying the number of pounds of butter credited to him by the average rate. Any charges for butter are deducted, and checks for the balance are delivered about the middle of the month.

The method may be illustrated as follows: Suppose a creamery receives in June 30,000 pounds of milk testing 3 per cent fat from A; 40,000 pounds of 3.4 per cent milk from B; 50,000 pounds of 3.7 per cent milk from C; 60,000 pounds of 4 per cent milk from D, and the total amount of butter made is 7,550 pounds. The operator reports these figures to the secretary, who fills them in the first two columns of a blank form, as shown below; the remaining numbers are then calculated from them and the data received from the sales agent. The work is sometimes done with great accuracy by carrying the decimals out several points, so that each patron always receives the exact number of cents due him. Frequently the secretary of the creamery slightly increases or decreases the amount to be distributed by changing the rate of payment a few hundredths of a cent per pound so as to enable him to use round numbers in his calculations instead of awkward figures. The difference is adjusted the following month. This system of borrowing from or loaning to the next month is very sensible. It greatly simplifies the secretary's work and, at the most, makes a difference of only a few cents in the returns to the various patrons, and these small amounts are not taken from them or given to them, but simply borrowed or loaned for a month.

Smithville creamery.—Statement for June, 1899.

Patron.	Milk delivered.	Average test.	Fat delivered.	Equivalent in butter.	Amount due.	Charges.	Checks.
	<i>Pounds.</i>		<i>Pounds.</i>	<i>Pounds.</i>			
A	30,000	3	900	1,044	\$229.68	\$2.00	\$227.68
B	40,000	3.4	1,360	1,577.6	347.07		347.07
C	50,000	3.7	1,850	2,146	472.12	1.50	470.62
D	60,000	4	2,400	2,784	612.48	5.50	606.98
Total	180,000		a 6,510	b 7,551.6	b1,661.35	9.00	1,652.35

a Overrun 16 per cent.

b At 22 cents.

Fat delivered.....	6,510
Butter made.....	7,551.6

Overrun, 16 per cent.		
Sales	3,000 pounds, at 25.5 cents	\$765.00
	2,000 pounds, at 25 cents	500.00
	2,000 pounds, at 21.5 cents	490.00
	551.6 pounds, at 21.1 cents	132.93
	7,551.6	1,887.93
7,551.6 pounds, at 25 cents		1,887.90
Charge for making, 3 cents per pound		226.55

Amount due patrons, 7,551.6 pounds at 22 cents

1,661.35

When there are many patrons it is seen that the number of calculations is very large. This laborious work could easily be lessened.



FIG. 1.—CREAMERY AT WATSONVILLE.



FIG. 2.—BUTTER CHESTS AWAITING TO BE PACKED.





FIG. 1.—CUTTING SQUARES OF BUTTER.



FIG. 2.—WRAPPING SQUARES OF BUTTER.

is more economical and satisfactory in many ways to use cheap but neat boxes for shipping, which do not have to be returned, than to use the heavy and expensive trunks or chests that were so common only a few years ago. These latter are continually being lost and broken, cause annoyance at both ends of the line, and require much labor for proper cleaning (and this is too often neglected), while the cheaper packages have not these objections.

CHEESE MAKING.

California dairymen and commission men are willing to admit that their State does not produce much cheese suitable for export. As a rule it is soft, open, and moist, and must be used soon after it is made.

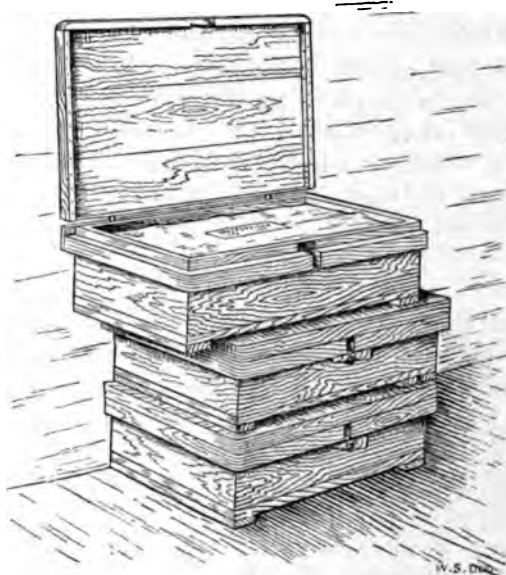


FIG. 1.—Butter packed ready for shipment.

The trouble, in all probability, is due to improper methods of manufacture, and the surest method of remedying the matter is to teach the science of cheese making and the systems successfully followed elsewhere. If such instruction were offered there is no doubt but that those interested would avail themselves of it.

Only one cheese factory was visited—a private concern on a ranch of 4,000 acres. Here the milk from 130 cows, mostly grade Durhams, is manufactured into “Flats” and “Young Americas.” The factory is a neat little one-story, square, brick structure, containing a curing room on the main floor and another below the level of the ground for use in hot weather. It is well equipped for making a fine article of cheese.

CITY MILK SUPPLY.

As in many other parts of the country, the business of supplying milk to California cities is in an unsettled state. There is a lack of cooperation between milk producers, health officers, and milk consumers, which is detrimental alike to the interests of those who have good milk for sale and those who wish to purchase it. Methods adopted by public officials for improving the milk supply sometimes result in more harm than good.

Unclean dairies have been so widely advertised in official reports and newspaper articles that many citizens think well-conducted dairies do not exist, or, if they do, no way is known by which one can be assured of getting their milk. And many persons will go without milk whenever possible rather than run the risk of getting the dangerously impure article which they are convinced is very common. Thus the scare articles have the effect of reducing the production and use of impure milk; but they have the same effect also on the use of pure milk. It is unfortunate that the excellent features of the best dairies are not given as much prominence as are the defective features of the worst, so as to show those interested that good milk is on the market as well as bad. A practicable plan by which this could be accomplished could easily be followed, greatly to the benefit of all concerned.

Although only a few dairies were visited, it was readily seen that at least a part of the milk going into Sacramento and San Francisco is produced with great care and can be relied upon as a safe and wholesome food. As already suggested, if these first-class dairies and others like them could be brought to the attention of the public as forcibly as the worst types, a decided step would be taken toward the improvement of the general city supply.

DAIRY EDUCATION.

In striking contrast with California's characteristic energy in advancing the interests of many of her industries in every possible way, the one method of promoting dairying, which in other States is considered of the greatest importance, has thus far been neglected. The State is doing nothing in the line of special dairy instruction, and her dairy interests are suffering in consequence. The reason may be that this branch of agriculture has not until recently become one of the important industries of the State, and those having power to assist in its promotion have not yet realized its great possibilities. Efforts to establish a State dairy school have been made, but without success. It was a subject of discussion at the dairymen's convention, and its friends will continue to agitate it, hoping that a school will be opened in the near future.

The necessity for such a school is readily seen. In the past few

years there have been many improvements and changes in dairy operations, and the improvements and changes still continue. Butter and cheese makers who now follow comparatively recent but really out-of-date methods are working at a great disadvantage. New forms of machinery are constantly being introduced, methods of manufacture are being perfected, market requirements are becoming more strict, and competition is growing more keen. In order to keep up with competitors at home and abroad it has been necessary to provide for giving instruction in the latest dairy methods, and special schools have been established in all the leading dairy States to meet this urgent need. It has been found best to connect them with State agricultural colleges, making use, so far as possible, of the latter's equipment.

In a few States splendid buildings have been erected for the exclusive use of the dairy schools. In other dairy States, where there is less call for instruction, there is less pretentious equipment, but the training offered is none the less complete. At Cornell University, New York, there is a building, erected and equipped at a cost of \$50,000, devoted exclusively to dairy instruction, and every year about seventy-five men are given a three months' course of lectures in breeding and feeding of dairy cattle and the manufacture of butter and cheese and practical work in a model creamery and cheese factory. At the State experiment station of the same State a \$40,000 building has recently been erected to be used chiefly as a laboratory for studying dairy problems for the benefit of the dairy interests of the State. At Madison, Wis., there is another dairy school building, which cost about \$40,000 and where more than a hundred dairy students are trained every winter. The wonderful growth of dairying in that State is attributed largely to the influence of the dairy school, graduates of which can be found in charge of successful cheese factories and creameries in almost every county. The dairy school at Ames, Iowa, is conducted in connection with a large creamery. Students are in attendance at all times of the year. Special sixteen-weeks' courses are given to beginners and a four-weeks' winter course is conducted each winter for experienced butter makers. Over 100 students are instructed every year. The cost of maintaining the school is less than \$3,000 per year, and a part of this is earned by the creamery. This school and others have furnished experienced butter and cheese makers to California. The other leading dairy States are also well equipped for giving instruction. Quite recently the legislature of Kansas appropriated \$34,000 for building and equipping a dairy school in that State.

Special instruction in dairying is offered at more or less well-equipped schools in thirty-one States. California is the only one in which the industry is at all prominent that is not on the list. The need of a dairy school in California is very apparent. The annual reports of the

State board of trade show the importance of the dairy industry as compared to others. The value of California dairy products is equal to two-thirds the value of her gold output, and far exceeds the value of any other mineral product. The dairy products are worth almost half as much as the wheat crop and about half as much as the combined crops of all kinds of fruit. The receipts from sales of butter, cheese, cream, and milk amount to nearly double the annual expenditures for the support of the public schools. According to the last census California ranks in dairying with other States as follows: Seventeenth in total number of cows; seventeenth in total butter product; ninth in total cheese product. Yet thirty-one States are ahead of her in encouraging and promoting dairying by offering special dairy instruction. It is seen that the dairy interests of many of them are smaller than those of California, both in toto and in comparison with other industries.

It is said to be a difficult matter to find capable operators of butter and cheese factories; and the same is true of helpers, even though these latter receive higher wages than farm laborers. As stated above, some well-trained factory operators have gone to California from other States. In addition to these there are some, of course, who have been successful in picking up their business at home and a few who have gone East for their dairy training and then returned to the State. But the majority of the butter and cheese makers of any large State will not be as well trained in their professions as they should be for the good of their work until a dairy school is maintained in that State and they shall have availed themselves of its advantages. This applies with special force to California, because it is so far from other leading dairy States and the expensive journey to their schools will prevent many from going away for dairy training who might do so if the distances were shorter.

BULLETIN No. 25.

(B. A. I. 142.)

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

D. E. SALMON, Chief.

RABIES.

REPORT OF THE COMMITTEE ON PUBLIC HEALTH
OF THE MEDICAL SOCIETY OF THE
DISTRICT OF COLUMBIA.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., July 9, 1900.

SIR: I have the honor to transmit herewith a report on rabies which was prepared by the committee on public health of the Medical Society of the District of Columbia and unanimously adopted by that society on June 13, 1900, and as this disease has for several months existed among the animals of the District of Columbia and vicinity I recommend its publication as Bulletin No. 25 of this Bureau.

Respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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RABIES.

REPORT OF THE COMMITTEE ON PUBLIC HEALTH OF THE MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA.

GENERAL STATEMENT.

At the meeting of the Medical Society of the District of Columbia, held April 11, 1900, the following preambles and resolution were adopted:

Whereas legislation concerning hydrophobia is contemplated by Congress; and
Whereas conflicting and even incorrect views as to the reality and nature of the disease have been expressed; and

Whereas this society, under the circumstances, should place itself upon record regarding the true status of the disease,

Resolved, That the matter be referred to the committee on public health for such action as it may deem proper.

In compliance with this action of the society the committee on public health, after having somewhat carefully reviewed the literature of the subject, giving due consideration to the facts and arguments presented pro and con, presented this report:

In view of the fact that this report is intended, as stated in the preamble, to be an expression of the views of the society upon the subject under consideration, it is deemed advisable to present, in a supplement to the report proper, additional facts and statements gathered from the literature upon the subject, which tend to further strengthen and justify the conclusions drawn. However, it is not to be inferred that the members of the society need any arguments to convince them of the reality of rabies or that the committee can further enlighten them concerning the disease, for they are, presumably, as well, if not better, informed upon the subject than are the members of the committee. Nor is this report intended to meet the objections of those who refuse to accept the biological test and who at the same time can not or will not believe the testimony, such as that here presented, of competent witnesses. Such persons could not be convinced—that is, if they are sincere—by seeing a case, even; simply because, having no other cases for comparison, there would be no means of verification.

Of the reality of the existence of rabies, or hydrophobia, both among man and animals, no reasoning or reasonable persons who will take

the trouble to investigate can for one moment entertain a doubt; and until such an investigation has been made no one has any right to make a positive assertion. That many persons, including physicians and other men of prominence, have never seen a case (although it may indicate the comparative infrequency of the disease, particularly in man) is no argument whatever against its existence. The same might be said in regard to a number of other diseases concerning which a doubt has never been expressed, or of the existence of a disease in a foreign country or city, for example.

In the index catalogue of the Surgeon-General's Office there are 31 pages, besides a large drawer filled with cards, devoted to titles of articles upon hydrophobia or to reports of cases that have occurred in nearly all parts of the world. These reports come mainly from perfectly reliable sources, and the articles, at least most of them, are by men of recognized authority, who believe in the reality of the disease and have had more or less experience with it.

The very eminent commission, consisting of Sir James Paget, president; Dr. Lauder Brunton, Dr. G. F. Fleming, president Veterinary College of London; Sir Joseph Leister, Bart.; Dr. Richard Quain, Sir Henry Roscoe, Prof. Burdon Sanderson, and Prof. Victor Horsley, appointed by the House of Commons of England in 1896 to investigate the new treatment for rabies as conducted by Pasteur, after a most searching and painstaking inquiry reached the conclusion that M. Pasteur had discovered a preventive method for rabies similar to that of vaccination for variola. Is it to be presumed that these gentlemen would have made this statement had they not believed in the existence of the disease? The select committee of the House of Lords appointed at a more recent date to examine into the subject of rabies among dogs sought and obtained the testimony of the most eminent authority of England upon the subject. This testimony alone, which is recorded in a book of 302 pages, is more than sufficient to establish the reality of rabies. Dr. Cabot, of the board of health of New York City, says he has heard from a number of prominent medical men, and none of them doubt the existence of the disease. He says the representative men in this country and in Europe—the men who do the thinking and teaching—recognize the importance of the subject. Dr. Welsh, of Johns Hopkins, says he believes most cases diagnosed as rabies by reputable physicians are rabies.

Moreover, rabies is an acute specific disease due to a specific cause, a virus—almost certainly a living germ or elaborated by a living germ—that is transmitted by inoculation only. This process, when it is accomplished, is brought about almost without exception by an animal which is suffering from the disease conveying to the wound inflicted by his teeth, either upon another animal or upon man, saliva which contains the virus. Of course, reference is not made here to

laboratory methods by which the disease is propagated experimentally by artificial inoculation.

The striking similarity, if not exact identity, of symptoms (and this anyone who reads the cases on record will observe) in man and animals, widely separated both as to time and place, can be explained in no other way than upon the assumption that the disease is due to a specific cause; and the fact that the disease has been transmitted from animal to animal, month after month, year after year, from the very beginning, without decreasing in virulence, can not be accounted for unless it is admitted that the virus is a living germ. Furthermore, the virus has been found to exist in the salivary glands, the saliva, the mammary glands and the milk, pancreas, lachrymal glands, and suprarenals, while its absence is noted in the liver, spleen, kidneys, urine, blood, and the bulk of the tissues; and, indeed, Memmo, of Rome, furnishes strong proof, asserting almost positively, that he has found the germ. He believes that Foll, Revotta, Ferran, and Spinello have seen the same germ also.¹ Besides, Nocard and Paul Best showed a number of years ago that saliva filtered through plaster lost its virulence; that is, that the virus was left on the plaster, and therefore most probably a germ.

The assertion that the disease is transmitted almost always by the bite of a rabid animal is based upon the facts in the case as testified to by any number of competent witnesses; and the assertion that it is transmitted only by inoculation is based upon a knowledge, in part inferred from analogy, of the nature of the virus, direct experiment, and the absence of any proof or possibility of proof to the contrary.

The claim occasionally made by some that ungratified sexual desire, long deprivation of food or drink, exposure to the intense heat of the sun, particularly during July and August, chaining or muzzling continuously, will produce the disease in the dog or other animal has never been substantiated and is contrary to the facts in the case. Dogs have been made to undergo all these cruelties now and then by perhaps overzealous investigators, but always with negative results. Such a claim, under the circumstances, is tantamount to the claim also sometimes advanced that the disease originates spontaneously or is produced *de novo*, which, like the charge that Pasteur has produced a new disease by his method of preventing hydrophobia, was proven by Pasteur himself to be impossible when he, in 1860, by his long since world-renowned experiment before the Academy of Sciences of Paris, exploded the theory of spontaneous generation.² The original jar containing the sterilized material, still with no signs of life, is yet to be seen at the Academy. It may as well be claimed that an artificial

¹Journal of American Medical Association, vol. 32, p. 327. Hereafter referred to simply as Journal.

²Journal, vol. 25, p. 587.

egg can hatch, or that a hen's egg can produce anything else but a chick, as to the claim that rabies can originate *de novo* or can be developed in any other way than from the specific virus of the disease. Surgeon-General Sternberg says that if there is anything definitely settled in medical science it is that rabies is an infective disease which is transmitted from animal to animal and from animal to man.

It is the laboratory method and the Pasteur treatment, however, that furnish the absolute proof of the inoculability and specific nature of hydrophobia. Dr. Kierle, of the Pasteur Institute, Baltimore, says that daily throughout the civilized world institutions administer the Pasteur treatment, demonstrating that rabies is a specific infectious neurosis, and that no other disease is capable of producing identical signs and symptoms. He further says that rabies is capable of unlimited propagation by experimentation. In such experimentation the inoculating material preferred is a portion of the floor of the fourth ventricle; and that by this method the Institute of Paris, starting with the medulla of a cow that had rabies from the bite of a rabid dog, has passed the disease from rabbit to rabbit until the four hundred and eightieth remove has been reached. Two rabbits have been trephined each time, making 960 rabbits that have taken the disease. Dr. Kierle himself, from the medulla of a cow that had rabies from the bite of a dog, has reached the one hundred and twenty-eighth remove, and has meanwhile given the disease to 738 rabbits. Using the medulla of a rabid horse, he has passed the disease from rabbit to rabbit until the tenth remove has been reached; and three times he has produced the disease in rabbits¹ from the virus from the human subject.

If these facts are admitted—and there is every reason why they should be—and if it is also admitted that the Pasteur preventive treatment has saved even one life, either in animal or man—and we believe the facts collected in the supplement prove that it has saved hundreds, if not thousands—then all the claims made in this report as to the nature and reality of the disease have been wholly substantiated, for upon no other possible assumption could the facts and treatment be explained.

HISTORY AND PREVALENCE.

Rabies has been known from very early times. Celsus described it, and a thoroughly accurate account of it appeared in an ancient Hindu work, probably ten thousand years ago. It existed all through the middle ages, and has prevailed and now prevails in nearly every country in the world, Lapland, Australia, and islands in the Pacific being possible exceptions. There are some sections where the disease prevails all the time; others, where it is unknown, although it is likely

¹ New York Med. Record, Feb. 19, 1898, p. 258.

to be introduced at any time unless the most vigorous quarantine is enforced against it. In locations where it has existed it may nearly or entirely disappear, only to break out afresh and perhaps become epizootic owing to its fresh introduction by some stray or imported dog. It exists at all seasons of the year. Of 2,520 cases, there occurred 704 in the spring, 621 in the summer, 608 in the autumn, and 587 in winter. (Johnson's *Cyclopedia*.)

There are good and sufficient reasons for believing that rabies has prevailed in this District, at least at times, for many years, and positive proof that it has done so each year since and including 1895; for the Bureau of Animal Industry demonstrated by the biological test its existence in 1895 in 2 cases, in 1896 in 5 cases, in 1897 in 3 cases, in 1898 in 7 cases, in 1899 in 19 cases, and in 1900 (to March 31) in 15 cases.¹

The following letter from the health officer of the District of Columbia adds information as to the existence and prevalence of the disease heretofore:

HEALTH DEPARTMENT, DISTRICT OF COLUMBIA,
Washington, May 10, 1900.

DEAR DOCTOR: An examination of the records of this department shows that since August 1, 1874, there have been 7 deaths of human beings from hydrophobia, in this District, as follows:

Record No. 14140: On December 19, 1877, William F. P., white, 17 years old, a butcher by trade, died on the heights of Georgetown from hydrophobia, the result of a dog bite, after three days' illness; he was attended by Dr. Louis W. Ritchie.

Record No. 26751: On December 7, 1880, John T. D., a white boy, 8 years old, died on G street, between Twenty-third and Twenty-fourth streets NW., from hydrophobia, after three days' illness; he was attended by Dr. William Ward.

Record No. 87009: On November 3, 1892, Charles H., colored, 27 years old, a laborer by occupation, died at 620 Third street SW., after four days' illness, under the professional care of Dr. Phillip B. Brooks. The patient had been bitten by a dog, but the cause of death was certified to as cerebral congestion, with a memorandum, however, to the effect that he was supposed to have died with rabies. A biological test was made by Dr. Kinyoun, which Dr. Presley C. Hunt, who was interested in the case, informs me, showed conclusively that the patient suffered from hydrophobia.

Record No. 98411: On September 25, 1894, John F. N., white, 12 years old, died at 1355 K street SE., from hydrophobia, after three and one-half days' illness; he was attended by Dr. Otto W. Schelksohn.

Record No. 99183: On November 14, 1894, Virginia G. M., white, 3 years old, died at 2915 Dumbarton avenue NW., from hydrophobia, after three days' illness; she was attended by Dr. Clifton Mayfield.²

Record No. 104454: On October 13, 1895, Bridget S., white, 54 years old, died at 224 L street NW., from hydrophobia, after four days' illness. She was attended by Dr. A. Behrend.³

Record No. 114571: On July 21, 1897, Charles E. S., white, 18 years old, a tinner by trade, died at 401 South Capitol street from hydrophobia, after three days' illness. He was attended by Dr. M. F. Thompson.

The record of the cases of rabies which have occurred among domestic animals does not extend back of 1895. During that year there were 3 cases; in 1896, 2; in

¹ Bu. An. Ind. Circ. No. 30, p. 6.

² Case published in Va. Med. Monthly, Richmond, 1894-95, vol. XXI, pp. 1078 to 1085.

³ Case published in Jour. Pract. Med., New York, 1895-96, vol. VI, pp. 242-244.

1897, 3; in 1898, 3; in 1899, 17; in 1900, up to the present time, 18. These numbers do not include any cases that were merely suspected, even though the clinical symptoms were reasonably well marked, except those in which the diagnosis has been confirmed by biological tests made by the Bureau of Animal Industry of the United States Department of Agriculture. Ten suspected cases are now under investigation by that Bureau.

If there be any further information which I can furnish, I shall be pleased to do so.

Yours, very truly,

WM. C. WOODWARD, M. D.,
Health Officer.

Dr. J. W. CHAPPELL,
Chairman Committee on Public Health, etc., Tennallytown, D. C.

SYMPTOMS.

As the symptoms of rabies have been frequently described and can be found in any text-book upon such subjects, they will be referred to here but briefly. The symptoms which correspond with, and are characteristic of, the three stages of the disease are—

First, the prodromal symptoms.

Second, the furious symptoms, or those of the attack proper.

Third, the paralytic symptoms, or those of the final stage.

If the symptoms of the second stage are absent or so slight as to escape notice, particularly if the first stage also is absent or of short duration, there exists what is known as the paralytic form of the disease. This may occur occasionally in man as well as animals, and is the form of the disease with which rabbits are usually affected.

In man the prodromal symptoms are indisposition, dread, and sleeplessness. The attack is ushered in generally by dyspnoea and a difficulty in swallowing. This difficulty in swallowing, particularly liquids, which is due to spasm of the muscles of the pharynx, rapidly increases. The spasms soon extend so as to involve first the muscles of the neck, and later those of the trunk and limbs. Any attempt at swallowing at this stage, or even the sight or sound of liquids, notwithstanding the patient's thirst is intense, is sufficient to bring on the most violent and distressing attacks of general convulsions. It is this peculiar and characteristic phase of the disease that has given rise to the term hydrophobia. The special senses become very acute, particularly those of hearing and cutaneous sensations, so that sounds and currents of air are sufficient to bring on the convulsive attacks. Stages of furious excitement or actual mania occur. Fever often reaches 103° to 104° F. Death may occur during this stage from asphyxia, from involvement of the diaphragm and other muscles of respiration; but more often the attack passes into the third stage, characterized by progressive weakness, and paralysis of the muscles of the limbs and trunk, death taking place by cessation of respiration. The duration of the disease is usually from two to five days. Those who have witnessed this form of the disease in man have characterized it as being

of the most terrible nature, and the sufferings of the patient as being beyond description. He, however, neither barks like a dog nor bites or otherwise attacks those about him. A change in disposition, particularly by seeking seclusion and manifesting signs of irritation upon being disturbed either by other dogs or by persons, particularly his master, is characteristic of the first stage of the disease in the dog.

In the second stage the dog's voice becomes affected, owing to incipient paralysis of the muscles of the larynx, and his bark or howl is said by those familiar with this symptom to be almost pathognomonic. His irritability increases, and he has spells, apparently uncontrollable, during which he attacks surrounding objects—chairs, carpet, his kennel, etc. These spells becoming more frequent, he wanders away from home, attacking persons as well as animals if they chance to cross his path, and, if he is naturally a vicious dog, he will go out of his way to do so. Often, too, he will chew up and swallow sticks, stones, pieces of coal, etc. Contrary to what is usually supposed by uninformed persons, he is not afraid of water, but will even plunge into streams, and in order to quench his intense thirst will make desperate efforts to gulp down the liquid, but which he has great difficulty in swallowing, owing to incipient paralysis of the muscles of the throat and lower jaw. If he is not killed, he usually returns home. The paralysis rapidly extends to the muscles of the lower limbs and trunk, involving those of respiration, and he dies. The usual duration of the disease is from four to five days, but may in very rare cases be prolonged to ten days.

The wolf, fox, and indeed most wild beasts when affected with the disease become very audacious, take to the fields and roads and will savagely attack men, horses, and cattle whenever they can find them. They usually fly at the exposed parts of the body—the hands and face; and for this reason their bites are more frequently followed by fatal results. In the cat the tiger-like ferocity predominates, and in her attacks she flies at the face and hands. The disease is sufficiently characterized in the rabbit by the fact that, while the hind legs are perfectly helpless, being paralyzed, it is able to drag itself around by the fore legs; the general health remains unimpaired and the appetite unaffected. The duration of the disease in the rabbit is from four to five days.

PERIOD OF INCUBATION.

The period of incubation is a variable one, depending, Pasteur says, not upon any difference in virulence of the virus, but upon the quantity absorbed. Hence it must also depend upon the character, situation, number, and severity of the bites; and this has been found to be the case. Its duration in man has been variously fixed at from 18, 20, 40, and 60 days to 2, 3, 12, and 24 months, and even longer.

The practical point is that it is usually of sufficient duration to allow the bitten person time to take the Pasteur treatment before the development of symptoms and of sufficiently indefinite duration to keep him in a state of anxiety long after all probable danger is passed.

DIAGNOSIS.

The symptoms of the disease in both animals and man are usually sufficiently characteristic to distinguish them. But a positive diagnosis can not be made without the laboratory test—that is, by inoculating rabbits or other animals with extract of the spinal cord of the person or animal supposed to have died of the disease. There are no sufficiently characteristic post-mortem appearances. For these reasons no one has any more right to positively pronounce a certain case followed by death as a spurious form of the disease than he has to pronounce every suspicious case genuine. Mistakes have occurred on both sides.

Drs. Head and Wilson, of the University of Minnesota, report a death which was supposed at first to be due to hydrophobia following the bite of a dog; but a post-mortem examination of the ventricular fluid and portions of the central nervous system revealed the presence of the diphtheria bacilli. Their presence was also determined by inoculation tests. The fact should be noted, however, that the patient lived 14 days after being taken ill, which was almost evidence enough itself to exclude hydrophobia.¹

Record No. 87009 of the health office of the District of Columbia, and referred to elsewhere in this report, is the record of a death certified to as one from cerebral congestion, but a biological test proved it to be a death from hydrophobia.

As the symptoms of the disease are to be relied upon more than the post-mortem finding, and as it takes from 14 to 21 days for the laboratory test, the suspected dog, if he has bitten other dogs, and particularly if he has bitten a person, should not be killed, but be confined where he can do no damage. His death in a few days would be confirmatory of rabies, while, if he does not die, it would be positive evidence to the contrary.

MORTALITY.

It is impossible to fix at all definitely the rate of mortality in persons bitten by rabid animals, for the statistics collected previous to the laboratory method of diagnosis are not entirely reliable, and persons bitten now by animals proven rabid usually undergo the Pasteur treatment. Besides, the mortality depends upon the seat, character, and severity of the bite or bites, their number, and the particular animal inflicting them. Bites about the head, face, and neck are especially fatal, while

¹Journal, vol. 33, p. 989.

those upon the limbs, particularly if through clothing, are not attended with much danger, as the clothing tends to rub the virus off the teeth. Bites of wild animals, the wolf in particular, are perhaps in the majority of cases followed by a fatal result. The rate of mortality for all bites has been fixed as low as 10 per cent and as high as 40 or 50 per cent. The mortality of bites of very severe character, especially if situated about the head, face, or neck, has been stated to be as high as 65 or 75 per cent, or even higher. Whether we accept these figures as approximately correct or not, we know that quite a number of deaths have occurred annually in nearly every country of the world from the bites of rabid animals.

TREATMENT.

As there is some little evidence going to show that thorough cauterization with nitric acid immediately or within 24 hours after the infliction of the bite of a rabid animal lessens the percentage of mortality, it is therefore to be recommended, whether it is intended to take the Pasteur treatment or not.

The Pasteur method has stood the test of time, but it should always be borne in mind that it is only a preventive measure, for if the symptoms once set in, or the treatment is delayed too long, it will, like all other remedies, fail.

There were treated at the Paris Institute during the three years ended December, 1898, 21,631 persons, of whom 99 died, a mortality of 0.45 per cent. The total number of cases reported by the other institutes and here collected are 6,440, of whom 47 died, a mortality of 0.73 per cent. This gives a grand total of 28,071 cases, of whom 146 died, a mortality of 0.52 per cent.

This committee is not certain whether those who died within the 15 days limit are included among the deaths or not, except in some cases. If they are not included, of course the mortality rate would be much higher, probably as high as 1 per cent. The committee is of the opinion that these deaths should always be stated in the report, and, except in cases where too long a time has elapsed before treatment is begun, they should be included with the other deaths. However, this evidence of the low percentage of mortality after the Pasteur treatment, and an actual decrease in the number of deaths from hydrophobia in France and other countries since its introduction, ought to be sufficient evidence of its efficacy.

The very eminent commission previously referred to in this report, appointed by the House of Commons of England in 1886, after a searching, painstaking, and independent investigation of the whole subject in all its phases, including a thorough inquiry into the cases that had thus far been treated, reached the conclusion that M. Pasteur had discovered a preventive method for rabies similar to that of vac-

cination for variola. Prof. Charles Richet, delegate of the French Government, and of the Faculty of Medicine of Paris, in a lecture delivered at the annual meeting of the British Medical Association, Montreal, while recounting the remarkable achievements of Pasteur and the great good resulting therefrom to the whole world, said, among other things, that the apogee of the glory of Pasteur was the discovery of the new treatment for hydrophobia.

Such is the character of the testimony in regard to this treatment.

The following observations, original with the committee as to the method of presentation only, are offered with the hope that they will prove to be a sufficient answer to those who claim (and there are some) that the Pasteur treatment is responsible for the deaths that occur:

In 1890 (?) eight children of Baltimore were bitten by a rabid dog. All were taken to New York and underwent the Pasteur treatment. Of the eight, four died within 36 days after being bitten and 19 days after the treatment was begun. Dr. Kierle says that it takes from 15 to 20 days at least for the treatment, and 15 days additional to establish complete immunity, and hence all cases that develop the disease within 35 days after being bitten prove by this fact that they are not susceptible to treatment.

Dr. Kierle first proved the existence of rabies in the dog that bit these children by a series of inoculations upon rabbits with emulsions of the spinal cord of the animal. Later he inoculated a number of rabbits with emulsions of the spinal cord of two of the children that died. In none of them did the disease develop prior to the fourteenth day. This fact proved very conclusively that it was ordinary "street" rabies, and not that of the laboratory, which develops in from 6 to 7 days after inoculation. This test has before and since been resorted to by others with like satisfactory evidence as to the nature of the disease.

The four children who died were all bitten on the face and bare neck and the wounds were severe. Three of the other children were bitten on the arm, and the remaining one was bitten on the ear through an ear warmer.

Louise Pelletier, who died December 3, 1885, a few days after the termination of the treatment, and who was the first patient lost by the Pasteur treatment, had been severely bitten in the armpit and on the back of the neck, and did not apply for treatment until 37 days after the infliction of the wound.

Some time after this, nineteen Russian peasants clad in the skins of wild animals applied for the Pasteur treatment. They had all been severely bitten by wolves 14 days before. Of the nineteen who came, sixteen returned home well. The three who died had received numerous and disfiguring wounds about the head, and in one the broken tooth of a wolf was found at the post-mortem embedded in the tissues.

The vast majority of the fatal cases following the Pasteur treatment presents a history similar to these. They have either been bitten on the bare neck or face, have received unusually severe wounds, or have allowed a longer time to elapse than is safe before applying for treatment. In some, all these unfavorable conditions exist together. If the treatment is the cause of the fatal termination, why is it that the mortality is so much greater in this class of cases than it is in those who receive only slight wounds, or wounds upon other parts of the body than those of the head, neck, and face, or who apply promptly for treatment? The inoculations are all made into the same part of the body and all are given the same treatment, except that in the most urgent cases a shorter method is sometimes resorted to, because experience has shown that more lives are thus saved.

Moreover, why is it that pain and other distressing symptoms are usually, if not always, felt at the seat of the bite when the dreaded disease first begins to make its appearance, while at the same time the seat of the inoculations remains in a perfectly normal condition?

The claim made by some that the paralytic form that has appeared in some of the cases treated is different from the form that develops from the bite of a rabid animal is proof that the disease is due to the inoculation is untenable, because this paralytic form existed before the days of inoculation. Van Sweiten recognized it in 1771; Brent recognized it in 1822; Watson described it in 1877. Moreover, the advocates of this charge show thereby that they acknowledge the existence of the disease in the usual form. But it has been shown that all the deaths after treatment are less by a very large percentage than are the deaths from the usual form without treatment. Is it not then eminently unfair and unjust to claim that the treatment causes the disease?

PREVENTION.

So long as the bites of dogs are followed, even occasionally, by death of a horrible nature, and so long as the Pasteur treatment offers the only possible means of escape from such a death, there will be found those who will regard it as a duty to provide means for those dear to them to undergo the treatment if bitten by a dog or other animal pronounced rabid by experts, and will regard it as a privilege to take the treatment themselves, should they be placed under like distressing conditions. But it takes three weeks, as has already been stated elsewhere in this report, to complete this treatment, during which time the patient would be required to remain away from his family and business, unless there were an institute in his own city, which is not the case in Washington; besides, the treatment, not to mention the pain and many other annoying incidents thereto, is very expensive, far beyond the reach of many, and who, unless the community comes to their relief, would have to forego it entirely.

Furthermore, so rapid is the rate of increase among dogs and so dangerous and devastating would they become in time, that some means must be devised for their destruction; and as the community in which we live has deprived its citizens of the right to carry firearms and other weapons by means of which they might protect themselves, and as defenseless children are compelled to use the streets and public highways in going to and from school and elsewhere, it is the duty of the community to insure against the incursions of dogs, as well as to afford every other possible means of protection.

Therefore, for these and similar reasons, your committee, while approving in the main the laws now in force in the District in regard to the keeping and licensing of dogs, as well as the laws in regard to the prevention and suppression of contagious diseases among domestic animals, and while urging their strict and impartial enforcement, would recommend that they be modified or amended as follows:

First. To prohibit dogs at all times from appearing at large upon the street, public highways, or elsewhere, without muzzles.

Second. To hold the owner liable in civil action for any damage done by his dog, whether or not a record has been kept at the collector's office of said dog.

Third. To require the poundmaster to collect dogs during the night as well as the day, providing a separate compartment in the wagon and at the pound for each dog, and destroying them in the most humane and practical way possible.

Fourth. To provide for the proper and safe keeping of any dog suspected of having rabies, especially if it has bitten other dogs or a person, until it is determined definitely whether it is rabid or not. Moreover, your committee most heartily approves of the recent order of the District Commissioners requiring all dogs when at large to be muzzled, but would urge a more rigid enforcement of the provisions, as dogs are often seen upon the streets not only with ill-fitting and insecure muzzles, but with none at all, especially at night.

Furthermore, the committee would urge that said order be continued in force, if it can be done legally, until the enactment of the provision, previously recommended, in regard to the muzzling of dogs, and would suggest the advisability of issuing to each dog owner, when he applies for his license, a circular containing the laws and regulations in regard to dogs, simple instructions as to their care, and a description of the symptoms of rabies; and would call attention to the necessity of all persons earnestly cooperating with the authorities in order to insure the faithful execution of the laws now in force and to bring about the adoption of the measures herein recommended.

Finally, the committee wishes it distinctly understood that it is unequivocally opposed to maltreating dogs or other animals or causing them to suffer in any way unless it is absolutely necessary for the

good of human society or themselves. It believes that no right-thinking and fair-minded person, particularly one who claims a special fondness or tender feeling for the brute creation, can object to these measures; for their proper enforcement, in addition to affording greater security to human society—their prime object—would prevent valuable dogs from getting rabies and protect them and all defenseless dogs from the cruel attacks of larger and more vicious ones.

J. W. CHAPPELL, Chairman.
 GEORGE W. JOHNSTON,
 E. A. BALLOCH,
 D. OLIN LEECH,
 T. A. CLAYTON,
 STERLING RUFFIN,
 R. A. HOLDEN,
 W. C. WOODWARD,
Committee on Public Health.

APPENDIX A.

Period of Incubation.

Watson says that the period of incubation in man is probably between 6 weeks and 3 months. In some cases it has been known to be of very much longer duration. He says that according to a table of 130 cases, prepared by Mr. Hawkins, the period of incubation for five-sixths of them was between 18 days and 3 months. He reports that in two persons bitten at the same time by the same cat that had been bitten by a dog the outbreak of the disease was 2 weeks apart; also that six dogs bitten at the same time went mad in 23, 56, 67, 81, 155, and 183 days, respectively. Pasteur thought the period of incubation would average between 40 and 60 days, and said that its length depends not on the virulence, but on the quantity of the virus absorbed. Hence a long period of incubation indicates that a small amount of the virus has been absorbed.¹

According to an article in the *Journal* (vol. 33, p. 1504), the period of incubation is said to vary from 20 days to 1 year. In 57.6 per cent of the cases reported it was from 50 to 120 days.

Horsley says it is not less usually than 6 weeks, but that it may last more than 2 years.²

E. Roux, in a paper read before the International Congress of Hygiene and Demography, in London, called attention to the long period of incubation of the disease, and says that the effects of the inoculations might be exhausted before the time for the development of the disease. In such a case the treatment would not, of course, prevent the appearance of the disease.³

Abba claims that the period of incubation in the dog is very variable. He says it has been proven to last 246 days, and that the only safe rule is to kill the suspected dog at once.

¹ Boston Medical and Surgical Journal, May, 1886, p. 500.

² *Journal*, vol. 16, p. 744.

³ *Journal*, vol. 17, p. 376.

Dr. Dolan fixes the probable limit of the period of incubation for sheep at 2 months, for pigs and horses at 3 months, and for cattle at 6 months.

Bradford says the period of incubation in man is from 20 to 60 days, rare after 3 months, still more rare after 6 months; in dogs, it is from 15 to 60 days, half of the cases occurring in less than a month; in cattle, from 1 to 3 months; in sheep, from 15 to 30 days; in the horse, from 15 to 60 days.¹

APPENDIX B.

Prevalence.

According to the census report of 1890 there were 63 deaths from hydrophobia in the United States.²

The bulletin of the Pasteur Institute, New York City, shows that in the year 1896 the 241 persons appearing for treatment came from 23 States.

Dr. Charles W. Dulles, who does not believe in hydrophobia, at least in its specific nature, in his report to the Pennsylvania Medical Society in 1894, says he has collected during the last 6 years reports of 78 cases, an average of 13 per year, or 1 to 4,500,000 inhabitants.³

Dr. John Ruhreah, of Pasteur Institute, Baltimore, says that there is great prevalence of the disease in Maryland and adjoining States, and that 17 of the 42 dogs examined by him proved to be rabid.⁴

In 1898 the Pennsylvania State board of health was obliged to quarantine against dogs in a village in the northern part of the State owing to the prevalence of rabies among horses, cattle, and swine.⁵

Westbrook and Wilson, in the report of the Minnesota State board of health, state that an examination of 19 suspected dogs, 16 of them were proved, by inoculation test upon rabbits, to have had hydrophobia.

Florida in 1895 added hydrophobia to the list of diseases to be quarantined against.

Fallon Cabbot, of the board of health, New York City, in the Medical News, March, 1899, says that Dr. Huidekoper made a special effort to find out the prevalence of rabies among dogs in the United States by writing to veterinarians in various parts of the country. As a result, he found that the disease was very prevalent in some sections, while in others (whole States even) there was none at all. He says that Dr. Fotheringham, of Boston, examined by the inoculation test 30 animals and that 20 of them proved to have rabies, including 1 horse and 1 cow. Rabies was found to be present in 14 of the 21 cases examined by Dr. Cabbot himself. He says Dr. Samson has seen 22 cases of rabies in animals. He quotes Dr. Welch, of Johns Hopkins, as saying that he believes rabies is more prevalent than is usually supposed; that we have means of recognizing hydrophobia as precise as those of typhoid fever—that is, by inoculation; and that he thinks most cases diagnosed by reputable physicians as rabies are rabies.

Dr. Cabbot also quotes Dr. Leonard Pearson, dean of the veterinary school of the University of Pennsylvania, as saying that he got authentic reports of the following deaths from hydrophobia in Philadelphia for the year 1896: Three men, 1 boy, 55 dogs, 3 horses, 6 cattle, 4 pigs, 1 goat, and 10 sheep.

Dr. G. W. McCaskey, of Fort Wayne College, reports two deaths from hydropho-

¹London Lancet, March 3, 1900.

²Wood's Medical and Surgical Monographs, vol. VII.

³Journal, vol. 22, p. 909.

⁴Journal, vol. 30, p. 1427.

⁵Journal, vol. 31, p. 1326.

bia after bites inflicted by dogs. No other case has ever been known in the vicinity before. He thinks that in his part of the country wild animals, such as skunks, squirrels, rabbits, and woodchucks might help to disseminate the disease.¹

Dr. Alfred C. Croftan, in the *Journal* (vol. 32, p. 1012), reports what he regards as the first case of hydrophobia in southern California. The symptoms in the patient were perfectly characteristic, and injection of the cerebro-spinal fluid into rabbits caused their death.

Dr. E. P. Axtell reports in the *Journal* (vol. 32, p. 1322) a death from hydrophobia in Denver, Colo.

Reports of many other cases from various parts of the country similar to the three just cited are on record, and a careful tabulation of them would be instructive and would undoubtedly reveal very general and wide prevalence of the disease in the United States, but this work, for want of time, was not undertaken by this committee.

Rabies is more prevalent in Europe than it is in this country. This is probably due to the facts that it is an older country and more thickly settled; that there are more dogs; that the disease is disseminated more frequently by dogs and other domestic animals than by wild ones; and that the quarantine laws are not rigidly and systematically enforced simultaneously by the different countries.

Ziensen says that in Prussia from 1820 to 1834 there were annually 71 deaths from hydrophobia, in Austria from 1830 to 1847 an average of 24 to 25 deaths annually, and in Bavaria from 1864 to 1867 there was an average of 17 to 18 deaths annually. He says in France the average death rate from hydrophobia is 2 to 1,000,000 inhabitants, and in Bavaria it is 4 to 1,000,000 inhabitants.

Sir Thomas Watson, Bart., in an article on hydrophobia published in 1877, says that Mr. Hawkins had seen 10 to 12 cases of the disease in man, and that he himself had seen 4 cases, and adds that, according to the report of the register-general, no less than 334 persons died in England of hydrophobia during the decade ended 1875. He says there has been an astonishing increase of the disease in England during the last half century; that in 1844 only 2 cases were admitted into St. George Hospital, but since the beginning of the present year 13 deaths had been recorded within the limits of London registration.

From January 1 to July 1, 1889, England sent 50 persons bitten by rabid dogs to the Pasteur Institute, Paris, for treatment. During July and August of the same year 39 persons were sent. This increase in number, however, was not due to a corresponding increase in the number of persons bitten, but to the fact that the treatment had been placed within reach of the poor by the provision of a fund.

An article in the *Journal* (vol. 26, p. 439) states that rabies became very prevalent in England, particularly in London and the surrounding counties, in 1889, and that during the year there were reported to the authorities 312 cases. After the use of the muzzle the number of cases very suddenly fell, until in 1892 there were but 38 cases reported. Then the number of cases reported began to increase soon after this, and amounted to a total of 248 for the year 1894.

In the department of Loire, France, in 1886, 53 persons were bitten by rabid dogs. One treated by a "quack" died; 26 of the remainder were treated by the Pasteur method.²

Professor Horsely says that rabies in England is known mostly in the midland counties, towns, and cities; that it is almost unknown in Scotland and Wales.³ Lapland is said to be free of the disease, although the dogs were proven to be susceptible to the disease by Pasteur, who inoculated two of them.⁴

¹ *Journal*, vol. 18, p. 91.

² *Phil. Med. Record*, vol. 32, p. 252.

³ *Phil. Med. Record*, vol. 32, p. 774.

⁴ *Philadelphia Medical Record*, vol. 30, p. 495.

The editor of the *Journal of Hygiene* calls attention to the increase of rabies since the introduction of the Pasteur Institute in Paris, and says that in one day (June 19 1888) there were 16 cases, 11 of which were from Paris.

An article in the *Journal* (vol. 32, p. 1012) calls attention to the increase of rabies in Brussels, where, late in 1898, there was almost an epidemic, owing to laxity in carrying out the restrictive measures.

Dr. Bradford, in the course of two lectures delivered at Brown University, February 13 and 20, 1900, says that there were reported to the board of agriculture, in 1892, 38 suspected cases of rabies; in 1893, 93 cases; in 1894, 248 cases; in 1895, 672 cases; in 1896, 438 cases; in 1897, 151 cases; and in 1898, 17 cases. In four years, from 1896 to 1899, he himself examined 259 suspected cases and found 138, or 53 per cent of them, to be genuine cases. He says that 264 of the 1,200 sheep in Richmond Park were affected with rabies.

Pasteur says that many islands in the Pacific Ocean are free from the disease.¹

APPENDIX C.

Percentage of mortality in persons bitten by rabid animals who were without the Pasteur treatment.

According to Ziemsen: Bites on the face, 90 per cent; bites on the hands, 63 per cent; numerous bites on the body, 63 per cent; bites on the lower extremity, 28 per cent; bites on the upper extremity, 20 per cent. All classes of bites combined, males 60 per cent, females 40 per cent. Age, he says, has no appreciable influence.

Sir Thomas Watson says that of those bitten but few get the disease. He quotes John Hunter as saying that he knew of 21 persons being bitten, of whom but 1 died, and Hamilton as estimating the mortality as 1 to 25; and yet Watson says that a dog in 1780 bit 15 persons, of whom 3 died of hydrophobia. He also reports that in 1774, of 17 bitten 10 died; in 1817, of 23 bitten 14 died; of 11 bitten at Dijon 4 died; of 24 bitten at Rochelle 18 died; of 19 bitten at Bar Sur Ornica 12 died. This gives a total of 114 persons bitten by wolves, of whom 67 died, a mortality of over 58 per cent.

Pasteur says that 16 per cent of those bitten in France died previous to the introduction of the inoculation treatment, and that the year before this method was adopted 19 deaths from hydrophobia occurred in Paris alone.² He gives the mortality of bites on the face without treatment as 65 to 95 per cent. He cites the history he got in 1877 of 11 persons bitten by wolves, 8 of whom died, and says that the prefect of police reported in 1887 that in the department of the Seine of 306 persons treated by the Pasteur method 3 died, a mortality of .98 per cent; of 44 not treated by the Pasteur method, 7 died, a mortality of 15.90 per cent.³

According to an article in the *Journal* (vol. 33, p. 1504), there were treated at the Pasteur Institute, Athens, since it was established in 1894, 797 cases, 7 of whom died, but 5 of these died inside the limit of 15 days after the termination of treatment. Meanwhile there were 40 deaths from hydrophobia among those not applying for treatment at the institute.

In a report of the Pasteur Institute, Chicago, the mortality for bites on the face is stated to be 88 per cent; on the hands, 67 per cent; on the limbs and trunk, from 20 to 30 per cent.⁴

Leblanc says that the mortality was 16 per cent before the Pasteur treatment.⁴

¹ Woods's Medical and Surgical Monographs, vol. VII.

² Boston Medical and Surgical Journal, May, 1886.

³ *Journal*, vol. 33, p. 303.

⁴ *Annual Report of Surgeon-General of Marine-Hospital Service*, 1898, p. 223.

APPENDIX D.

Treatment.

Treatment by the Pasteur method will be gone into here somewhat at length mainly for the reason that to establish its efficacy is to settle all the essential controverted points. It will prove at one and the same time the existence of the disease, both among man and animals; its specific nature and character of the virus; and it will show its wide prevalence and the existence of a sufficient number of cases to warrant every possible means for its suppression. The Pasteur method of preventive treatment has stood the test of time, and has proved to be absolutely safe and in the vast majority of cases entirely reliable. It should, however, constantly be borne in mind that it is a preventive measure only, for, the symptoms of the disease having once set in, or if the treatment is not begun in time for it to have its effect before the end of the period of incubation, it will, like all other remedies, fail.

This method, which was for the first time and successfully applied to the boy Meister in 1885, after Pasteur had succeeded in proving its efficacy upon 50 dogs, consists in injecting hypodermically into the subcutaneous cellular tissue of the abdomen for a number of consecutive days a certain amount of an emulsion or extract of the spinal cord taken from a rabid rabbit in which the disease has been artificially produced and definitely fixed by passing through a certain number of them, the spinal cord having been dried from 1 to 14 days in a jar containing caustic soda, which process caused them to lose more or less of their virulence, according to the length of time of exposure.

The following method, although it may be deviated from slightly, especially in case the bite is a very severe one or situated about the face or neck, or in case a long time has elapsed since its infliction, is that generally carried out at the Pasteur Institute in Baltimore, under the direction of Dr. Kierle, and may be taken as a type of all the rest.

Having first thoroughly disinfected the place selected for the injection, and having determined that the cord is free from pus germs by a culture test, there are given on the first day two injections of 3 cubic centimeters each of the extract of a cord that has been dried 13 or 14 days by the process already referred to; on the second day two injections of 3 cubic centimeters each of a cord 11 or 12 days dried, and so on for 21 days. From the first to the fifth day two injections are given daily; after that but one is given. For the first 4 days 3 cubic centimeters are given daily; after that 2, except on or about the ninth day, when a less quantity—say, 1.5 cubic centimeters—is given. Each day for 5 consecutive days a cord one day more potent—that is, a cord dried one day less than that of the preceding day—is used. After this time cords dried from 3 to 5 days are used on different days until the end of treatment. Cords dried but 2 days are seldom used, and those dried but 1 day never.

Besides the 8 Pasteur Institutes in France, there have been established in Russia 6, in Italy 5, in Austria 2, in New York 1, in Chicago 1, in Baltimore 1, in Habana 1, in Rio Janeiro 1, in Buenos Ayres 1, in Saragossa 1, in Malta 1, in Bucharest 1, in Constantinople 1, in Aleppo 1, in Tiflis 1, in Athens 1—making 34 in all; and although they were all founded under the supervision of the pupils of the Paris Institute, and remained under their direction until well under way, they have now become entirely independent of the mother institution.

The Pasteur Institute of Chicago gives, in the Journal for July 29, 1899, the following summary of results since the establishment of the institute: "Number of patients treated, 780, of whom only 3 died, a mortality of 0.38 per cent. Seven hundred and nine were bitten by dogs, 29 by cats, 26 by horses, 7 by skunks, 5 by wolves, 2 by cows, 1 by a calf, 1 by a rat, 1 by a mule, 1 by a pig, and 3 by hydrophobic human beings. Two hundred and sixty-eight were bitten by animals proven to be rabid either by the laboratory test or by the death of other persons or animals bitten by

the same animal. Three hundred and fifty-eight were bitten by animals recognized to be rabid by their symptoms. One hundred and sixty-one were bitten by animals strongly suspected to be rabid. Three hundred and seventy-seven persons received severe and multiple lacerated bites on the hands and wrists, 92 on the head and face, 110 on the arms, 173 on the legs and thighs, and 28 on the trunk."

The bulletin of the Pasteur Institute, New York City, gives the number of patients for the year as 241. There were treated 236 persons consecutively without a death. Of those treated, 224 were bitten by dogs, 13 by cats, and 3 by human beings. From the founding of the institute, in February, 1890, to January, 1897, there were treated 962 persons, of whom 12 died, a mortality of 1.24 per cent. The editor of the bulletin says that if those who died within 15 days after the termination of the treatment are excluded, which is the European practice, there would be but 5 deaths, a mortality of 0.52 per cent.

The bulletin of the Pasteur Institute of Paris for 1897 gives the statistics of the Pasteur Institute of Tiflis for the year 1896 as follows: "Cases remaining over from the previous year, 12; new cases, 230—making a total of 242 treated. Of these, 33 were efficiently cauterized, 152 inefficiently, and 57 not at all. One hundred and ninety-three were bitten by dogs, 6 by horses, 2 by cats, 1 by a wolf, and 1 by an ass. Fifty of the cases occurred in the spring, 85 in summer, 55 in autumn, and 9 in winter. There were 3 deaths, but of 1 which occurred 15 days after treatment, a mortality of 0.41 per cent."

The following is a summary of the report of the Pasteur Institute at Rio de Janeiro, Brazil, from its foundation until June 30, 1898. There applied for treatment 4,068 persons. In 1,373 cases treatment was refused; in 3 because symptoms had already appeared, and in the others because it was discovered that they were not bitten by rabid animals. In 2 of the rejected cases symptoms afterwards appeared. Two thousand three hundred and eighty-three were bitten by dogs, 287 by cats, 2 by mules, 1 by a cow, 2 by asses, 1 by a horse, 4 by monkeys; 3 had contaminated sores, and 10 had been accidentally inoculated in the institution. Ninety-nine did not wait for the termination of the treatment, and of them 3 were taken with hydrophobia after leaving. Five died of other diseases during treatment, and in 6 hydrophobia made its appearance before the termination of treatment. Of the 2,585 receiving full treatment, 20 died—9 within 15 days after termination of treatment—a mortality of 0.77 per cent. One thousand nine hundred and thirty-five had been bitten on exposed parts. One thousand five hundred and forty-five were residents of Rio de Janeiro, the remainder coming from different parts of Brazil.

The report of the Pasteur Institute of Baltimore for the year 1897 shows number of cases as 35, without a death. Twenty-five of the patients were bitten by dogs proved to be rabid.¹

A report of the Pasteur Institute of Paris for the year 1895 gives the total number treated as 1,520, with 2 deaths, a mortality of 0.13 per cent, the lowest of any year up to that time. In the completed report up to 1898 the deaths for the year 1895 are reported as 5 instead of 2. This would seem to indicate that in this latter report those who died before the lapse of 15 days after the completion of the treatment have been included.

The report of the Pasteur Institute, Algiers, March, 1900, shows that there were treated in the department of Algiers 645 cases; in the department of Constantin, 557 cases; in the department of Oran, 632; and in that of Tunis, 2, thus making 1,836 cases, in 9 of which the patients died, a mortality of 0.49 per cent.

¹ Journal, vol. 30, p. 1175.

The following is the report issued by the Pasteur Institute of Paris, and is complete up to the end of the year 1898:

Year.	Treated.	Died.	Mortality.
			<i>Per cent.</i>
1886.....	2,671	25	0.94
1887.....	1,770	14	.79
1888.....	1,622	9	.55
1889.....	1,830	7	.38
1890.....	1,540	5	.32
1891.....	1,559	4	.25
1892.....	1,790	4	.22
1893.....	1,648	6	.36
1894.....	1,387	7	.50
1895.....	1,520	5	.33
1896.....	1,308	4	.30
1897.....	1,521	6	.39
1898.....	1,465	3	.20

This gives a total of 21,631 treated during the 13 years.

APPENDIX E.

The muzzle a means of prevention.

[Extract from a paper read by Fleming before the Seventh International Congress of Hygiene and Demography, London, August 10-17, 1891.]

Rabies being transmitted, as a rule, by the bites of dogs, and, as in any case in which the disease prevails there can be no certainty when a dog is not infected, if it at all times be prevented from inflicting wounds by its teeth, it is evident that the danger of extension of the malady must be reduced at least to a minimum. Dogs can be hindered from biting by causing them to wear a properly constructed muzzle, and if it fits well it should cause very little, if any, inconvenience to them.

Rabid dogs sometimes escape from home without their muzzles, and the absence of these is an indication that they should be seized; and wandering and ownerless dogs are also known by their not wearing muzzles, and can therefore be secured by the police.

The value of the muzzle in suppressing rabies has been demonstrated on many occasions, and in serious outbreaks of the disease its introduction has always coincided with a diminution in the number of cases, and the eventual extinction of the scourge. Its use is always coincident with a decrease in the number of cases of hydrophobia occurring among people during such outbreaks, and their ultimate cessation. The evidence in support of this statement is so voluminous and explicit that anyone examining it must be convinced as to the certainty of the fact. Two or three instances may be cited.

In the report of the royal commission on rabies, it is stated that "in the city of Berlin special regulations are in force. In consequence of a severe outbreak in the year 1852, during which 107 dogs were destroyed as rabid, the royal police issued a decree to the effect, on July 2, 1853, that all dogs should be provided with a wire muzzle, positively preventing the animal from biting, and to empower special persons, appointed by the police for that purpose, to seize and destroy all dogs not so muzzled and, when the owner could be found impose a fine of 10 thalers (11.10s.) or a term of imprisonment. In the year following this decree only 1 dog was killed as rabid, against 97 in the previous year. The decree still remains in force, but does not seem to have been effectual in preventing the recurrence of epidemics of rabies;

for the number of dogs killed as rabid, which up to 1863 had not exceeded 9 in any year, rose progressively in the succeeding years, until in 1868 the number had reached 66, declining again to 7 in 1870, only to increase in 1872 to 69. In 1875 a law was passed, extending to the whole of Prussia, for the suppression and prevention of animal disease which provides that all dogs suspected of rabies shall be immediately killed, as also all animals which it is evident have been bitten by rabid animals; and that all dogs in a district which has been infected by an outbreak of rabies shall be confined, or, when abroad, both muzzled and led. The technical section of the veterinary board in Berlin are of opinion that the passing of this law, and not alone the existence of the muzzling order in that city, is the cause of the extinction of rabies in Berlin. No case has occurred there since 1883."

In Vienna we are informed that rabies was entirely suppressed by 18 months of stringent muzzling; but in the summer of 1886 the muzzling order was rescinded, and badges had to be worn on dogs' collars instead. In the following half year there was only one case of the disease, but in the next half year rabies became epidemic, and the muzzle had again to be worn, with the result that the malady soon subsided and disappeared. Consequently the muzzling order is still rigidly and most beneficially enforced in Vienna.

In Holland, before 1875, rabies was prevalent to a very serious extent; but in June of that year the use of the muzzle was ordered, with the result that in the autumn the number of cases fell to 41; in the next whole year there were 55 cases; in 1877 there were 14; in 1878 there were 4, and in 1879 there were 3. These, and the cases which have since been reported, occurred only on or near the frontier of Belgium, in which country the muzzle is not in use, though rabies is always prevalent. To such a degree, indeed, does the disease exist in Belgium that in 1889 there were brought to the veterinary school at Brussels no fewer than 94 really rabid dogs, 49 having been admitted during the winter quarter, and 45 during the summer quarter; and from January 1 to April 24, 1890, 16 were taken there.

In the Grand Duchy of Baden during the years 1871, 1872, 1873, 1874, and 1875 the number of cases of rabies was, respectively, 18, 37, 37, 50, and 43. Then the muzzle was rigorously applied, and in 1876 there were 28 cases; in 1877, 3; in 1878, 4; in 1879, 2; in 1880, 2; in 1881, 2; in 1882, 3; in 1883, 2, and in 1884, 2. Since that year only 1 case has been observed, and that was a dog from Metz, where there were no proper regulations, which had been contaminated before its arrival at Baden.

In Sweden rabies was at one time a somewhat common disease, and from 8 to 10 people died annually of hydrophobia; but (muzzling being enforced and the importation of dogs prevented) rabies has been unknown for many years, and no deaths from hydrophobia have occurred since 1870.

In England the value of the muzzle has been as well exemplified as elsewhere, though its application has always been extremely partial, being only employed in towns or districts when rabies has increased to such an extent as to create alarm and removed immediately when the disease had for the time disappeared. No effective action has at any time been taken to suppress rabies in England or Ireland. In the latter country it is always more or less prevalent, and ever since it was first legislated for in England it has maintained a permanent existence in the following fourteen counties, viz, Chester, Derby, Essex, Hants, Kent, Lancaster, London, Middlesex, Notts, Surrey, Sussex (East), Sussex (West), Warwick, and York (W. R.). During the year 1890-91 cases of rabies were reported for the first time in three counties previously free from it; these were Bucks, Norfolk, and York (E. R.); and it was reintroduced into Leicester after an absence of two years, and into Stafford, which had been free for one year.

The extent to which rabies has prevailed in this country may be judged from the loss of human life through bites from rabid dogs. It is stated that in England (including Wales) there have been 939 deaths from hydrophobia recorded during

the past 38 years, the yearly average for the first 16 years being 8, for the next 16 years 15, and for the remaining period, ended in 1885, 45. Thus the mortality has steadily advanced through more than 400 per cent. On the other hand, the Prussian preventive measures have reduced deaths from hydrophobia to a remarkable degree, for while in the decade ended in 1819 there was a yearly average of 166 deaths, in a similar period ended in 1886, there was a yearly average of $4\frac{1}{2}$.

The value of the muzzle in suppressing rabies has been perhaps best demonstrated in London on several occasions, and especially in 1885. In the previous years hydrophobia had increased to a very alarming extent, as has just been mentioned, in England, and no steps worthy of note had been taken to check the mortality. For London alone in that year no fewer than 27 deaths were reported as due to the bites of rabid dogs. A muzzling order was then enforced, and at the end of 1886 not a death was recorded. Unfortunately the order prescribing the use of the muzzle was then rescinded, and in a few months a case of hydrophobia occurred in the south of London, soon to be followed by others, and in 1889 10 deaths were registered. In July of that year the muzzling order was again issued and stringently carried out, and rabies and hydrophobia once more disappeared.

In other countries where rabies prevails and dogs are not muzzled, though other measures, as the dog tax, medal on the collar, leading by a leash, etc., are enacted, the malady continuously manifests itself, and numbers of people perish from hydrophobia every year. We may give Belgium and France as examples. In the latter country the monthly sanitary bulletin shows to what an extent it is prevalent, and I need only to refer to the last two which I have to hand—those for March and April of the year 1891. In March 132 dogs and 8 cats were destroyed as rabid, besides those sacrificed as a preventive measure, while 32 persons, as well as cattle and pigs, were bitten by mad dogs. In April 151 dogs and 4 cats were destroyed because of being rabid, and a large number were killed because they had been bitten by mad dogs or were wanderers, and 47 persons were wounded by mad dogs. The reports of the Pasteur Institute show that by far the largest proportion of persons protectively inoculated are French. There can be no doubt that if the use of the muzzle were enforced generally and strictly throughout France rabies would quickly vanish from the sanitary bulletins.

Belgium has tried all other recognized measures except the muzzle, and yet the malady is as rife and deadly as ever in that country. A royal commission was recently appointed to inquire into the subject, and the report addressed to the Superior Council of Hygiene in April last states that the regulations in force are insufficient, and while not testing the value of Pasteur's preventive inoculations with regard to people bitten by rabid dogs, it is urged that there is something far more desirable, and that is the extinction of the disease in the canine species. For this object the commission insists upon the immediate adoption of the muzzle.

Senseless sentimentality has opposed the use of this article in a most extraordinary manner in this country, and one would be inclined to believe that there are people who care less for human suffering and human life than for a little inconvenience or discomfort to dogs. A well-fitting muzzle should cause very trivial inconvenience and discomfort, while insuring absolute safety from dog bite. Repeatedly rabid dogs have been brought to veterinary surgeons wearing muzzles, and so rendered safe, as it is a well-known fact that a diseased dog will, in nearly every instance, allow those it knows to handle it and put on a muzzle. A leash only is no protection, for the dog can bite and is as dangerous as if not led. Frequently rabid dogs on the leash are brought to veterinary surgeons. It is also perfectly obvious that a collar, no matter how embellished and bemedaled it may be, will no more prevent rabies or hinder dogs from biting than will a linen collar on a man's neck preserve him from smallpox or influenza. But we need not stay to notice these ridiculous notions.

APPENDIX F.

AN ACT to create a revenue in the District of Columbia by levying a tax upon all dogs therein, to make such dogs personal property, and for other purposes.

[1 Sup. R. S., 374.]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there shall be levied a tax of two dollars each per annum upon all dogs owned or kept in the District of Columbia; said tax to be collected as other taxes in said District are or may be collected.

SEC. 2. It shall be the duty of the collector of taxes, upon receipt of said tax, to give to the person paying the same, for each dog so paid for, a suitable metallic tag, stamped with the year, showing that said tax has been duly paid; and he shall keep a record of all such payments, with the date thereof, and the name, color, and sex of such dog, and the name of the person claiming any dog so paid for; and a copy of such record, certified under the hand and official seal of the said collector, which shall be given to any person demanding the same, upon payment of twenty-five cents therefor, shall be prima facie evidence of such payment in any court in the District of Columbia.

SEC. 3. The poundmaster of the District of Columbia shall, during the entire year, seize all dogs found running at large without the tax tag, issued by the collector aforesaid, attached, and shall impound the same; and if, within forty-eight hours, the same are not redeemed, by the owners thereof, by the payment of two dollars, they shall be sold or destroyed, as the poundmaster may deem advisable; and any sale made by virtue hereof shall be deemed valid to all intents and purposes in all the courts of the District of Columbia.

SEC. 4. Any dog wearing the tax tag hereinbefore provided for shall be permitted to run at large in the District of Columbia, and shall be regarded as personal property in all the courts of said District; and any person injuring or destroying the same shall be liable to a civil action for damages, which, upon proof of said injuring or killing may be awarded in a sum equal to the value usually put upon such property by persons buying and selling the same, subject to such modification as the particular circumstances of the case may make proper.

SEC. 5. Any person owning any dog so recorded in the collector's office shall be liable in a civil action for any damage done by said dog to the full amount of the injury inflicted.

SEC. 6. It shall be the duty of any person owning or possessing a dog to place, or cause to be placed and kept, around the neck of such dog, a collar, on which shall be marked and engraved, in legible and durable characters, the name of the owner or possessor, and the letters "D. C.," and to which collar must be attached the insignia or tax tag furnished by the District tax collector, in accordance with the first and second sections of this law, under the penalty of not less than five nor more than ten dollars; and if any person shall put, or cause to be put, a collar, with the insignia or tax tag, around the neck of any dog owned or possessed by any person or persons residing in the District, without having obtained a license for keeping such animal, he, she, or they shall forfeit and pay the sum of not less than five nor more than ten dollars for each and every offense.

SEC. 7. Whenever it shall be made to appear to the Commissioners that there are good reasons for believing that any dog or dogs within the District are mad, it shall be the duty of the Commissioners to issue a proclamation requiring that all dogs shall, for a period to be defined in the proclamation, wear good, substantial muzzles securely put on, so as to prevent them from biting or snapping; and any dog going at large during the period defined by the Commissioners without such a muzzle shall be taken by the poundmaster and impounded, subject to the provisions of section three.

SEC. 8. Any person who shall remove, or cause to be removed, the collar and insignia or tax tag from the neck of any dog, or entice any properly licensed dog into any inclosure for the purpose of taking off its collar or insignia, or shall for such purpose decoy or entice any animal out of the inclosure or house of its owner or possessor, or shall sieze or molest any dog while held or led by any person, or shall bring any dog into the District for the purpose of taking up and killing the same, shall forfeit and pay a sum of not more than twenty dollars.

SEC. 9. If any owner or possessor of a fierce or dangerous dog permit the same to go at large in the District of Columbia, to the danger or annoyance of the inhabitants, he shall forfeit and pay, for the first offense, ten dollars; for the second, a sum not exceeding twenty dollars; and upon a third conviction for the same offense, the Commissioners shall immediately cause the dog, upon account of which the conviction takes place, to be slain and buried.

SEC. 10. That all acts or parts of acts now in force in the District of Columbia inconsistent with the provisions of this act be, and the same are hereby, repealed.

Approved June 19, 1878.

Extract from An Act for the establishment of the Bureau of Animal Industry.

[1 Sup. R. S., 2d Ed., 437.]

SEC. 8. That whenever any contagious, infectious, or communicable disease affecting domestic animals, and especially the disease known as pleuro-pneumonia, shall be brought into or shall break out in the District of Columbia, it shall be the duty of the Commissioners of said District to take measures to suppress the same promptly and to prevent the same from spreading; and for this purpose the said Commissioners are hereby empowered to order and require that any premises, farm, or farms where such disease exists, or has existed, be put in quarantine; to order all or any animals coming into the District to be detained at any place or places for the purpose of inspection and examination; to prescribe regulations for and to require the destruction of animals affected with contagious, infectious, or communicable disease, and for the proper disposition of their hides and carcasses; to prescribe regulations for disinfection, and such other regulations as they may deem necessary to prevent infection or contagion being communicated, and shall report to the Commissioner of Agriculture whatever they may do in pursuance of the provisions of this section.

Approved May 29, 1884.

